The Impact of Farmer Field Schools on Technical Efficiency of Tobacco Production: A Case Study of District Swabi

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A dissertation presented to Pakistan Institute of Development Economics, Islamabad in fulfillment of the requirements for the degree of Masters of Philosophy (M.Phil) in Economics

Department of Economics

PAKISTAN INSTITUTE OF DEVELOMENT ECONOMICS, ISLAMABAD

2017

Pakistan Institute of Development Economics

CERTIFICATE

This is to certify that this thesis entitled: **"The Impact of Farmer Field Schools on Technical Efficiency of Tobacco Production: A Case Study of District Swabi"** submitted by Mr. Mubassir Zubair is accepted in its present form by the Department of Economics, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree of **Master of Philosophy in Economics**.

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Dedicated to

My Beloved Parents, Brothers and Sisters

ACKNOWLEDGEMENTS

First of all I would like to thank Allah (SWT) for giving me the strength and understanding to complete this research successfully. I am also obliged to my family members especially my beloved parents and my brother and sisters who supported and encouraged me throughout the journey and made it possible for me to complete my thesis. I would also like to thank my respected supervisor Dr. Muhammad Nasir who provided valuable guidance and made it possible for me to complete my research on time. In addition, I am grateful to the farmers who participated in my research and facilitated the data collection procedure. Moreover, I would like to thank my friends specially Umer wahid, Touqir Ahmed and Mazhar who accompanied me in the farm visits. Last but not least, I am extremely grateful to Beenish Javed for her valuable guidance and moral support throughout my research.

Mubassir Zubair

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ABSTRACT

Tobacco is one of the agricultural commodities which is widely produced around the world. In Pakistan out of all the provinces, KPK is famous for tobacco production and particularly district Swabi for the production of the Flue Cured Virginia tobacco; as its agronomic and environmental conditions are suitable for its production. In agriculture sector the improvements in efficiency and introduction of new technology can enhance productivity. Agricultural productivity in the short-term can be enhanced by improvements in efficiency as the acquisition rate of new technology is quite low in Pakistan. The Farmer Field School (FFS) approach is one of the ways to improve the efficiency in agriculture sector however, FFS program has not been evaluated for tobacco sector in Pakistan. Hence the study is conducted to examine the effect of FFS on efficiency of tobacco growers in the district Swabi. Using the stochastic production frontier approach and propensity score matching technique, the study revealed that FFS played a significant role in enhancing the efficiency of tobacco farmers in Swabi. That is, the tobacco production of the Treated group was significantly greater than that of the Control group. This difference in the efficiency was accountable to the extension visit which is a source of knowledge dissemination among the farmers.

Keywords: FFS, Tobacco, Efficiency, Stochastic Frontier Production, Propensity Score Matching.

Chapter I

INTRODUCTION

Agriculture contributes significantly in meeting the basic needs of individuals. The general role of agriculture extension in crop productivity and the specific role in enhancing the livelihoods of people in rural areas are recognized by different international organizations and agencies (Hassan *et al.*, 2013). Agriculture is one of the essential instruments which can be used by the farmers to fight various challenges such as famine and poverty which are prevalent in many developing nations (Abdullah and Rahman, 2015). Tobacco is one of the agricultural commodity which is widely produced around the world however the major tobacco producing countries are India, Brazil, China, USA, Indonesia, Pakistan, Turkey and Zimbabwe. Pakistan ranks 6th in the production of tobacco (GOP, 2014). In Pakistan amongst all food and non food crops, the tobacco crop has features of its own. Tobacco is an important cash crop not only in Pakistan but throughout the world. The reason being that about 30% of the government revenue comprises of receipts from the CED (Custom and Excise Duties) on tobacco (Rahman *et al.,* 2011).

Moreover the return from tobacco per acre is higher than other cash crops in the country. In addition to that it provides employment opportunities since it is a labor oriented crop and is an important source of foreign exchange earnings. Out of all the provinces, KPK is famous for tobacco production and particularly district Swabi for the production of the Flue Cured Virginia tobacco; as its agronomic and environmental conditions are suitable for its production. In agriculture sector the improvements in efficiency and introduction of new technology can enhance productivity. Agricultural productivity in the short-term can be enhanced by improvements in efficiency as the acquisition rate of new technology is quite low in

Pakistan (Javed *et al*., 2008). In order to attain the prolong growth in efficiency, productivity & agriculture differentials have to be diminished by enhancing the managerial skills of the farmers communities and development of infrastructure. (Ghura and Just, 1992; Pingali *et al*., 1997). In this scrim, agricultural production's efficiency measurement is the important sketch in developing nations. Farrell (1957) propagated two components of economic efficiency namely allocative and technical efficiency. The term technical efficiency refers to the ability to produce the maximum output from given set of inputs and technology while allocative efficiency can be defined as the ability to generate given output using the cost minimizing set of inputs. The concept of economic efficiency provides a theoretical base for measuring the producer's performance. Agriculture sector acts as an effective tool for economic development. Tobacco productivity growth acts an important determinant of long-term economic growth which in turn affects living standard of the society. Improvements in productivity lead to increased returns for the producers and labor and increase the consumption.

A small number of studies have been conducted on estimating the technical efficiency of tobacco crop in Pakistan (Saddozai *et al.*, 2015 ; Qazi and Robert, 1990). Therefore there is a need to conduct study on investigating the technical efficiency of Pakistan's tobacco crop. The present research will assist the farmers to locate factors that influence the technical efficiency of tobacco production. Moreover for increasing the output it is necessary that the tobacco growers have better knowledge and skills about farming and proper use of machinery, sowing seed, fertilizer, irrigation and harvesting etc. Extension methods play a vital role in transmission of skills & knowledge.

At the end of 1980s the farmers in Indonesia were massively using pesticides, the use of which was adversely affecting the crops, environment as well as the health of the farmers. The pest species were becoming resistant. Hence there was a need for educating the famers so that they can better manage their fields. Thus the approach of Farmer Field Schools (FFS) came to the rescue of farmers (Dilts, 2001). Farmer Field Schools (FFS) consist of many farmers who get together to study, collect data, analyze and make decision. FFS provide opportunities for learning by doing and teach basic agricultural and managerial skills in order to enhance the expertise of farmers (Vande-Fliert, 1993). Just like other developing countries, the history of agriculture extension is long in case of Pakistan too. Many agricultural strategies are being used in the country since 1950s. Moreover the agricultural extension field staff is making efforts to induce the farmers to enhance the productivity of their crops (Luqman *et al.,* 2005).

In so far as the history of Pakistan's agriculture extension is considered, the Training & Visit Programme was the first Programme to be used. It was initiated in 1978 and was an important means of providing the extension and rural development services to the farmers (Mallah *et al.,* 1997). Many studies have shown that the Training & Visit Programme is more effective than other Programmes for agricultural extension (Hussain *et al.* 1994; Garforth *et al.* 1995; Lodhi, 2003). The traditional agricultural extension system was facing many issues because of limited coverage, reliance on the contact farmers, sampling biasness, inadequate management and technical skills of the extension staff (Davidson, 2001; Ashraf *et al.,* 2001). As a result of all these drawbacks; the managers of the extension system had to substitute with another strategy in order to solve the issues of farmers (Jurgen *et al.,* 2000).

The Farmer Field School (FFS) methodology of agricultural expansion was the most appropriate one given the state of agricultural system globally. Owing to the success of FFS in Indonesia, many other South Asian countries introduced such a Programme (Braun *et al.,* (2005). FFS was introduced in Pakistan in order to educate the wheat and cotton growers about the Integrated Pest Management (IPM) practices (Duveskog and Friss-Hansen, (2008). Due to its success, the Government of Punjab also adopted it by the name of "Fruit & Vegetable Development Project", the purpose of which was to train the vegetable and fruit farmers through the approach of FFS (Government of Punjab, 2012). The Programme was adopted in all the districts of Punjab where fruit and vegetables were produced including Sargodha, Vehari and Sheikhupura that specializes in the production of citrus.

According to Buhler *et al.* (2000), the FFS is used for achieving high crop yield. It motivates the farmers to increase their efficiency and profit margin in crop production (Braun *et al.,* (2005). FFSs are spreading at a fast pace around the world in terms of its entry topics and geographical distribution. Nonetheless, various organizations have raised concerns regarding its relative cost, the time consuming nature as well as the affect of the approach. Despite the large investments in Asia that have been made in FFS few studies have been conducted on examining their impacts (Tripp *et al.,* 2005; Habib *et al.,* 2007; Saddozai *et al.,* 2013; Tahir *et al.,* 2015).

Tobacco is the main cash crop of KPK. It is cultivated in Mardan, Swabi, Charsadda, Mansehra, Swat, Dir and Malakand agency. Rustica tobacco is a type of tobacco which is cultivated in the area of Rajanpur (Punjab) and in district of Baluchistan. This type of tobacco is used in snuff. In KPK tobacco is cultivated on 3% of the area. Flue-cured Virginia which is used in cigarettes is cultivated in KPK on 25,000 to 30,000 hectors of land. The Rustica type of tobacco is cultivated in KPK on 10,000 to 15,000 hectors of land. Barely any type of tobacco is being cultivated in areas of Swat and lower Dir. Throughout Pakistan KPK have the most suitable agro-climatic conditions for the production of tobacco, flue-cured Virginia as well as for Rustica type of tobacco. Following sugarcane, tobacco is the 2nd major income source for the farmers of KPK. Tobacco is cultivated 20% in Swabi, 50% in Charsadda and 30% in Mardan. Hence Swabi is the third major producer of tobacco in KPK. The cost of labor is the major element in tobacco production as it is required for carrying out different operations such as nursery raising, transplantation, inter-cultivation and heating up. Application of fertilizers, insecticides, irrigation, picking of leaves, stitching of leaves on sticks , loading into burns, curing unloading and carriage to market; all of these operations are carried out by the cultivators and their family members themselves. Consequently, it provides employment to almost 400,000 people in KPK.[1]

Given this backdrop, the study at hand is conducted to know about the effect of FFS on efficiency of tobacco growers in the district Swabi because FFS program has not been evaluated for tobacco crop in Pakistan.

1.1 Objective of Study

The main objective of the study is to investigate the effect of farmer field schools on Technical efficiency of tobacco production in district Swabi. In addition, the study also intends to explain the channels through which FFS could affect efficiency of tobacco farmers.

[1] www.Brecorder.com

1.2 Hypothesis

The present study will test the following null hypothesis against the alternative hypothesis:

H_0: There is no impact of farmer field school on technical efficiency of tobacco.

H_1: There is an impact of farmer field school on technical efficiency of tobacco.

1.3 Main Findings

The underlying study reveals that FFS played a significant role in enhancing the efficiency of tobacco farmers in the study area. The efficiency of the treated group was found to be greater than that of the Control group. That is, the tobacco production of the Treated group was significantly greater than that of the Control group. This difference in the efficiency was attributable to the extension visit which is a source of knowledge dissemination among the farmers and greatly contributed in enhancing the technical efficiency.

1.4 Contribution and Significance of Study

Different studies are conducted in agriculture for different crops that use FFS approach nationally and internationally. The FFS has been successful in improving the efficiency of various crops such as rice, wheat, cotton, cocoa, sugarcane, fruits and vegetables and onion etc. These crops have a significant share in Gross Domestic Product (GDP) but no study has been conducted in case of tobacco using this approach nationally and internationally. Moreover the studies that have been conducted for tobacco have analyzed various aspects of tobacco farming at nationally and internationally. The studies incorporate cost return & profitability analysis, production and its marketing system. The main focus of most of the researchers was on the production of tobacco and such studies used cost-benefit analysis. However efficiency is a key factor of productivity enhancement particularly in agriculture wherein resources are limited. Furthermore if FFS is successful in increasing the yields of other crops; it does not necessarily imply that it would prove to be effective in increasing the efficiency of Tobacco growers. The current study makes important contribution to the literature. For example, to our knowledge, this is the first study that explores the impact of FFS on the efficiency of tobacco growers. Secondly, this study adds to the above literature by identifying an important channel that is extension visits through which FFS affects efficiency of tobacco production. This study is also a significant contribution to the policy debate in agriculture sector in the province. It suggests that the FFS program increases efficiency through skill and knowledge enhancement by providing guidance by making extension visits to the field. In addition, the FFS program also tries to reduce farmer's risk and insure them against unforeseen events. The findings of the present study could be beneficial for various researchers and tobacco growers as well. Since the results showed a favorable impact of FFS on the efficiency of tobacco production, it recommends to the policy makers the expansion of FFS program throughout the province.

Chapter II

HISTORICAL OVERVIEW OF FARMER FIELD SCHOOL

Farmer Field School aims to enhance skills and knowledge of the farmers so as to make them experts in their own field. It also aims to stimulate the critical thinking of farmers in problem solving as well as help them learn to manage themselves and their communities. The word Farmer Field School comes from two Indonesian words i.e. "Sekolah Lampangan" that simply means "Field School". At the end of twentieth century the excessive use of pesticides was adversely affecting the crops, environment as well as the health of the farmers in Indonesia. In addition, is as a result the pest species were becoming resistant. Thus the measures were needed in order to educate the famers for effective management of their fields and this led to the establishment of Farmer Field Schools (FFS) approach (Dilts, 2001). The Integrated Pest Management Farmer Field School (IPM-FFS) & large-scale Indonesian Programme initiated due to the aforementioned circumstances. These concepts have been useful across various cultures and nations in which the FFS has been utilized and has led to the empowerment of farmers. From the perspective of donor support since the late 1960s the major crop protection approaches include the Calendar-based applications, surveillance systems, ETL-based decisions by farmers and Farmers as experts of IPM (Pontius *et al.*, 2002).

One of the main issues with most of the development in the IPM has been the generalizations and recommendations that it tends to make for farmers across different areas. The success of state monitoring & forecasting systems have been limited by the issue of ecological heterogeneity. The solution is for the farmers to become experts in IPM. The suggestions for each approval disclose a smooth evolution in the accommodation of ecological heterogeneity. The Asian governments have established policies that support one or more of the four approaches discussed above. Over the last four decades, some countries have used each one of the approaches or more simultaneously. Sometimes the nations have used new approaches without discontinuing old approaches. The four approaches that are presented in chronological order of emergence tend to place a load on the user in terms of the analysis, observation & ecological knowledge. More data is required for decision making by each approach respectively and the decisions that are made tend to cover smaller units of time and area. The improvement in decision making led to lesser pesticide usage and better control of pests.

The FFS was introduced in order to tackle the issue of ecological differences and to assign the agro ecosystems to those individuals who can manage them more appropriately (Pontius *et al.*, 2002). The FFS can change significantly- originally it was practiced in rice but now in soil husbandry, animal husbandry, organic agriculture, water management, health and handicrafts. Between 1991-1994, FFSs spread from Indonesia to Bangladesh, China, India, Cambodia, Lao PDR, Philippines, Vietnam & Srilanka with the help of the inter-country IPM Programme introduced by the Food and Agriculture Organization (FAO). During 1991-1994 FFS shifted its focus from single-crop to secondary or rotation crops and vegetables. NGOs played a better role in developing and spreading FFS approaches. Thailand adopted this approach in the form of "IPM in Schools". Similarly Bangladesh adopted this approach in rice-fish IPM-FFS; and world education used this approach in farmer adaptive research approaches. In order to enhance the model of FFS various innovations like gender advocacy, field ecology, health impact studies, farmer planning and farmer-led action research were considered by national Programmes and FAO (Cip-Upward, 2003). The first group of FFS farmers graduated in 1990 and the first FFS started in Indonesia & then by 1993 it gained popularity in other nations like Bangladesh, Cambodia and Vietnam and then from 1995-1999 it established in China, Nepal & Srilanka (Cip-Upward, 2003).

Owing to the reputation in Asia of the IPM-FFSs, there was a shifting to replicate and modify this approach to various other regions. FFS further spread primarily, in the form of rice IPM to vegetables and cotton IPM in Asia (Ooi, 2003). Following the success of the approach in Asia, it was also adopted in Latin America in the form of potato IPM and vegetable Integrated Production and Pest Management (IPPM) in Africa. Later on it was also used in Middle East for controlling Corn Rootworm in Eastern and Central Europe and recently in East Africa in crops, dairy cows, poultry (Jiggins *et al.*, 2005; Leisa, 2003a and 2003b; Cip-Upward, 2003; Agridape, 2003).

FFS gives better result all over the world in different fields. This approach resulted from “optimal learning derives from experience in case of farmers”, notion from surveillance in the field. Opportunities to farmers are also provided by the FFS in order to learn about the crops and from one another by combining the non-formal education and ecological. Conducting field observation, growing healthy crops, conserving predators of pests are some of the objectives of FFS. The FFS based IPM approach was initiated in 2001 in Pakistan.

There are different types of FFS all over the world but they are not same, it depends upon topic setting because FFS have different goals such as in case of IPM and IPPM. It is anticipated that it will enhance pest management practices and also farmers’ production. Water and Soil management FFS focus on soil husbandry problems while Dairy FFS focus on dairy practices. Also FFS focuses on non agricultural based learning due to increasing FFS learning process such Reproductive Health Field Schools in Kenya and Farmer Life Schools in Cambodia

2.1 Strengths and Weaknesses of FFS

2.1.1 Strengths

Empowerment of human resource is considered as a prerequisite for successful community based services, projects and interventions. But sometimes such interventions are not successful because of the low level of human empowerment such as in Africa. Hence FFS can play a significant role in human resource empowerment thereby leading to successful provision of services in the community (Duveskog and Friis-Hansen, (2008).

There are many strengths of the FFS Programme such as building self-confidence especially for women, motivates teamwork and enhances management skills. One of the most important strength is that it develops and improves social capital of the community. This occurs because FFS allows the farmers to have their say in the decision making process. Moreover, farmer-to-farmer extension opportunity is also provided by the FFS in areas that have inadequate formal extension staff such as in pastoral areas and dry lands. The FFS can acts as a platform through which inputs can be supplied on emergency basis. Moreover, organizational capacities as well as agriculture training can also be enhanced through it. FFS can also be promoted as a national extension system because of its package like concept which makes its scaling up easier.

2.1.2 Weaknesses

FFS has some limitations also such as it cannot be considered as the greatest tool for achieving rapid & extensive application of recommendations. Moreover, it is costly given the decreasing agricultural budgets. As a result of poverty many poor families seek to meet their short term needs and hence spend a lot of time in looking for casual work. Furthermore, education is not free hence investment cost is involved. This limitation is being overcome by the farmers who raise funds through FFS.

2.2 Future of FFS

The future of FFS is bright as investments are being made in the farmer organization managed Programmes. The forecast is that due to the increasing interest in “education for all”, the FFS would be encouraged on the other hand programs like agriculture extension would fall as a result of limited technology transfer and the failure to adapt. The self-financing is making the FFS Programme cheaper and more effective in many ways. The critics are likely to start acknowledging the role of FFS and reduce their criticism of local ownership by the farmers.

2.3 Farmer Field School in Pakistan District Swabi

The FFS Programme in district Swabi was initiated with the support of Pakistan Tobacco Company (PTC).The branch district of PTC in Swabi was established in 1980 respectively. Furthermore, the registering and training of farmers started in 2002. The FFS in study area has regional manager who is responsible for the supervision of tobacco production at the district level. For example manager is allotted few areas in district for the supervision such as Yar Hussain, Kernel Sher Kali and Kalu Khan etc. Furthermore, purchase manager is responsible for grading, purchasing and meetings in the respective areas. Moreover, a surveyor is hired on contractual basis that monitors the nursery of each tobacco grower. The growers are also asked about their willingness to grow more tobacco or wheat. Furthermore the farmers receive fertilizers, pesticides, higrometer,Plupipes, Protective Productive Equipments and standard spray pump and seeds etc on subsidized rates. The reason the farmers are not able to successfully register or get in agreement with FFS is due to lower quality and quantity of tobacco, cumbersome procedures and prejudiced mindsets.

Chapter III

REVIEW OF LITERATURE

3.1 FFS and Efficiency in Agriculture Sector

There are some management practices in agriculture realm such as Organic Agriculture, Best Management Practices (BMP), Farmer Field Schools (FFS) and Zero Tillage that are used for increased crop production (Buhler *et al.,* 2000). In the midst of the aforementioned approaches, FFS is an approach that encourages the farmers to improve the efficiency of crop production and earn greater profits (Braun *et al.,* 2006).

About thirty years ago an experiment was introduced in Asia with the name of Green Revolution. According to the approach the productivity of small farmers can be increased if they are provided with certain inputs which if they use in a prescribed manner. Green Revolution was a success especially for the small-scale farmers who positively responded to the opportunities. As a result, productivity increased considerably. However green revolution had its costs as well. The reliance of agricultural development programs on a highly centralized system increased under the Green Revolution. The centralized systems did not take into consideration the agro ecological heterogeneity within countries, regions and villages. Severe ecological damage was done because of the application of pesticides in the routine. Green Revolution was unable to mold the use of input to local circumstances (Kenmore, 1991).

In the late 1980s, researchers found that the crop yields were declining across Asia. The main reason for this decline was the environmental degradation that resulted from intensive use of pesticides and intensive crop monoculture. Moreover the International Rice Research Institute (IRRI) researchers pinpointed the expertise of farmers as a potential source of decrease in yields. Hence it was realized that training of farmers is essential for improving the crop yields (Pingali *et al.,* 1990). The Farmer Field Schools approach thus emerged from the consequences of green revolution.

Many researchers around the world have examined the effectiveness of FFSs in promoting the productivity and efficiency of farmers. For instance, Chigozie (2002) investigated the concept and role of FFS in Africa for achieving sustainable agriculture. The study finds out that the multidisciplinary research agenda will not only result in development of technology but will ensure participation of stakeholders, validation and dissemination of technological development. This approach would lead to sustainable agriculture in Africa besides increasing agricultural productivity.

Similarly Braun *et al.,* (2000) investigated the impact of local agricultural research committees and Farmer Field Schools for sustainable agriculture and concluded that FFS enhances the skills of farmers as managers. On the same lines Iqbal *et al.,* (2012) examined the effect of FFS on the rice productivity in district Malakand for the period 2004-2005. The findings of the study revealed an encouraging change in the approach of farmers as a result of practices adopted under the FFS approach. Furthermore David (2007) analyzed the effectiveness of the Sustainable Tree Crops Program (STCP) farmer field school for cocoa production in Cameroon.

The study concluded that the farmers' knowledge and skills improved as compared to farmers who are not registered under the FFS Programme. Similarly, the effect of FFS on the production of cotton in 4 districts of Sindh was investigated. FFS was successful in enhancing the knowledge of farmers regarding the use of pesticides and nutrient management (Siddiqui *et al.,* 2012). On the same lines Saddozai *et al.,* (2013) investigated the contribution of FFS in promoting technical efficiency of cotton making in the southern Punjab. The study revealed that the farmers who were registered under the FFS had 38 % more cotton production as compared to the farmers who were not registered under the FFS Programme. In contrast Feder *et al.,* (2004) examined the impact of FFS in Indonesia but the study found that the FFS Programme did not significantly contribute in increasing the yields or in minimizing pesticide use.

According to Gershon *et al.,* (2003) FFS is a training approach which gained popularity since last decade in many developing countries. The FFS Programme gained popularity in Pakistan when Food Agriculture Organization (FAO) in 2001 implemented the IPM Programme for cotton in Sindh (Khan *et al.,* 2005). Since Godtland *et al. (2004),* Habib *et al.* (2007), Amir *et al.* (2013), Yorobe *et al.(2011)* and Muhammad *et al.* (2013), Mwaura (2014) and Tahir *et al.* (2015) analyzed the effect of Farmer Field School in sugarcane, onion, cotton, rice and potato etc. From the above analysis of literature it can be concluded that no study has been conducted on examining the effect of Farmer Field Schools (FFS) on the efficiency of tobacco growers nationally or internationally. Thus the present study aims to cover the gap in literature by analyzing the effect of FFS on the efficiency of tobacco production in district Swabi.

3.2 Empirical Studies of Efficiency Measures in Agriculture Sector

The researchers are concerned with the measurement of efficiency so as to examine the farmers' efficiency. The concept of efficiency has number of dimensions. Overall the satisfaction of allocative and technical efficiency is required to achieve economic efficiency. Various methods have been used in literature for measuring technical efficiency such as ordinary least squares (OLS) regression, total factor productivity (TFP) indices utilizing price-based index numbers (PIN) and, stochastic frontier analysis (SFA). The OLS methods are famous because of their implementation ease however the form of the function needs to be specified for production technique. In addition, data about the average performance is provided rather than frontier performance. The latter problem has been overcome by SFA that is an econometric technique which specifies a composite error term whose one part captures data noise & the other captures inefficiency. PIN methods like the famous Tornqvist TFP index also experience some issues as access is required to the reliable price information and scale effects are not explicitly accommodated.

Recently the famous way of measuring the output has been the "*data envelopment analysis*" (DEA), developed by Charnes *et al.* (1978), that covers up these shortcomings. DEA has been used as an accepted instrument in economic analysis of production units. DEA is Linear programming technique utilized in estimating production frontier & used widely for the estimation of technical efficiency (Cooper, Seiford; Tone, 2000). It calculates the type & amount of cost and resource savings that can be achieved through making each unit that is inefficient as efficient as the best practice units. In other words, DEA compares service units by taking into account all resources and services used and pinpoints the most efficient and inefficient units. Specific changes are pinpointed in the inefficient units which can be implemented by the management to achieve potential savings located with DEA. Furthermore, information about the performance of service units is received by the management. This information is used to assist transfer system and expertise of the efficient units. DEA easily accommodates multiple inputs and multiple outputs which is the key advantage of DEA. DEA compares and identifies the best practice units (branches, departments, individuals) and the inefficient units in which the improvements in real efficiency are possible (Sherman and Zhu, 2013). Numerous studies have been conducted abroad and in Pakistan that have used DEA in the investigation of farm efficiency, health care, education, banking, manufacturing, benchmarking, management evaluation, fast food, restaurants, retail store and many others. Furthermore this technique has been applied in fisheries in United States Northwest Atlantic sea scallop fishery (Kirkley *et al.*, 2001), Pacific salmon fishery (Hsu, (2003), the Scottish fleet (Tingley and Pascoe, (2003) and Malaysian purse seine fishery (Kirkley *et al.* (2003). Heidari *et al.* (2011) examined broiler farms' technical efficiency in the province of Iran by using Data envelopment approach. Similarly Areerat *et al.* (2012) investigated technical efficiency of broiler farms in the four areas of chiang mai province of Thailand by using Data envelopment approach. Likewise Mahjoor (2013) examined the Economic efficiency in the province of Iran using Data Envelopment Approach (DEA).

Furthermore economic efficiency of broiler growers in the three provinces of Egypt was investigated by Omar (2014) using data envelopment approach. Moreover, Dao and Lewis (2013) estimate the technical efficiency of annual crop farms in northern Vietnam by using DEA approach. Murthy *et al.* (2009) examined the determinants of tomato production as well as technical efficiency in India by employing DEA approach. Javed *et al.* (2009) conducted the technical, allocative and economic efficiency of cotton-wheat in Punjab by using DEA technique. Javed *et al.* (2008) utilized DEA approach to investigate the efficiency of rice-wheat cropping system in Punjab. Similarly Ali *et al.* (2010) analyzed the production efficiency of cucumber in Punjab using similar technique.

As we know DEA is non-parametric approach that makes use of mathematical programming to locate the efficient frontier. DEA cannot test the hypothesis nor accommodate noise and does not specify the functional form so to hypothesize the functional form & use the data econometrically to approximate the parameters, the researchers used parametric approach. So like DEA approach Stochastic Frontier Approach (SFA) is also used to approximate efficiencies. Aigner, Lovell, Schmidt and Meeusen and Van den Broeck introduced the SFA. It is a parametric approach whereby a functional form is hypothesized and data is used to estimate the parameters of the function econometrically.

Several studies have used SFA approach to estimate technical efficiency in the agriculture sector. For instance Okezie and Okoye (2006) measure the determinants of technical efficiency in case of growers of eggplant in Nigeria. Likewise the economic efficiency of pepper production was assessed by Dipeolu and Akinbode (2008) for Nigeria. Furthermore Dolisca and Jolly (2008) investigated the technical efficiency of Haiti's potato and bean production. Moreover the determinant and technical efficiency of Yam production in Nigeria was evaluated by Shehu *et al.* (2010). Likewise Baree (2012) investigated onion farms' technical efficiency in Bangladesh. On the same lines Azizi and Moghaddasi (2012) examined the economic efficiency of potato farmers in Iran. Similarly Sibiko *et al.* (2012) analyzed the determinants of productivity & technical efficiency among bean farmers in Uganda. Donkoh *et al.* (2013) analyzed technical efficiency of tomato in Ghana. Furthermore, the technical efficiency of potato farmers in a province of Afghanistan was assessed by Srinivas *et al.* (2014). Likewise, Abedullah *et al.* (2006) examined the technical efficiency of potato in Punjab and Bakhsh *et al*. (2007) estimated bitter guard's technical efficiency in the same area. Similarly Khan and Saeed (2011) investigated economic efficiency of production of tomato in Nowshera district of KPK. While the technical efficiency of tomato in the Peshawar district of KPK was examined by Khan and Ghafar (2013).

The review of the above literature indicates that the impact of FFS on tobacco production has not been investigated so far in the literature. Thus the present study is conducted to examine the impact of FFS on tobacco production in district Swabi, Pakistan.

Chapter IV

CONCEPTUAL FRAMEWORK OF EFFICIENCY MEASUREMENT

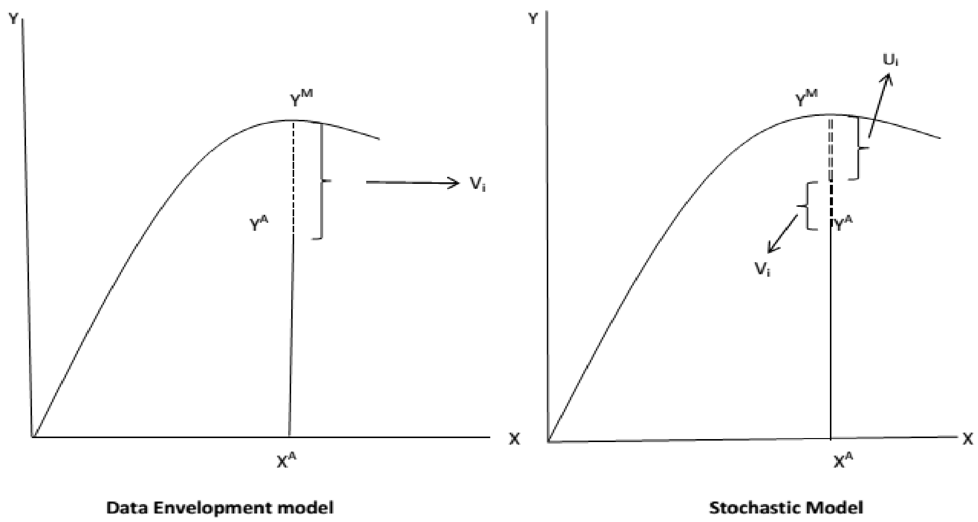
Economic efficiency can be defined as the ability of the firm to generate the established amount of output at least cost given a particular state of technology (Farrel, 1957; Kopp and Diewert, 1982). One of the components of economic efficiency is the productive efficiency. Productive efficiency pertains to the production of output at a minimum cost. The second component is technical efficiency that refers to the capacity of the firm to generate highest level of output from the given input set also known as output oriented technical efficiency. Alternatively it refers to the capacity of the firm to generate a given level of output with minimum inputs that is called input oriented technical efficiency. The ability of the firm to utilize the inputs optimally given the input prices and production technology is known as allocative efficiency. An input is said to be allocatively efficient when the marginal product become equal to its prices.

Technical efficiency is measured with 2 types of techniques specifically parametric (Stochastic Frontier Analysis) and nonparametric (Data Envelopment Analysis). These two approaches have their own pros and cons. The main benefit of DEA is that apart from input and output quantities no other information is required. The efficiency is calculated in comparison to the highest observed performance instead of an average. Nevertheless, the estimates of DEA are sensitive to noise & errors because it characterizes all deviations from the frontier to inefficiencies and is deterministic. The strong point of SFA is that noise in data is also taken into account and statistical testing of hypothesis regarding degree of inefficiency and production structure. Therefore Stochastic Frontier Analysis (SFA) is utilized for formulating the efficiencies of tobacco farmers. In the stochastic frontier model, it is assumed that the stochastic production function bounds the output.

The stochastic frontier function has a composite error term that is farmer's inefficiency and random errors (Battese and Coelli, 1995; Coelli *et al.,* 1998). Stochastic frontier production function that is applied to measure the efficiencies of tobacco growers is described mathematically as below:

$$\mathbf{Y_i = \mathit{f}\ (X_i; \beta_i) + \varepsilon_i \qquad i = 1 \ldots n} \tag{1}$$

Whereby; Y_i is the production, Xi denotes the inputs, β is the production function's parameter whose value is unknown and ε represents composite error term that consists of 2 components as given below:



Source: Adopted from kumbhakar and Sarkar (2004).

Figure 4.1: Variation in tobacco output due to various factors

$$\mathbf{\varepsilon_i = v_i + u_i} \tag{2}$$

where;

v_i = is a symmetric element that depicts the output changes caused by factors which are out of farmer's control like plant disease, earthquake, breakdowns and climatic conditions.

μ_i = is an asymmetric element that captures the deviation in the output caused by the inefficiency factors of farmers.

Technical efficiency **(TE)** can be defined as the ratio of actual output condition **(Yi)** to Frontier output **(Yi*)** given the technology available:

$$\mathbf{TE_i = Yi/Yi^*} \qquad (3)$$

Where;

Y_i = i^{th} tobacco grower's output

Y_{i*} = output of tobacco growers operating at frontier

TE_i = i^{th} grower's technical efficiency (ranges between 0 and 1)

$$TE_i = \frac{\exp(X'i\beta + vi - ui)}{\exp(X'i\beta + vi \colon ui{=}0)} \qquad (4)$$

The value for technical efficiency lies between the range **$0 \leq TE \leq 1$,** and if **$TE = 1$** then farming is conducted in efficient environment and vice versa.

While allocative efficiency in farming occurs where the price equals to the marginal cost of production that is **P = MC**. The following figure 4 depicts the allocative efficiency:

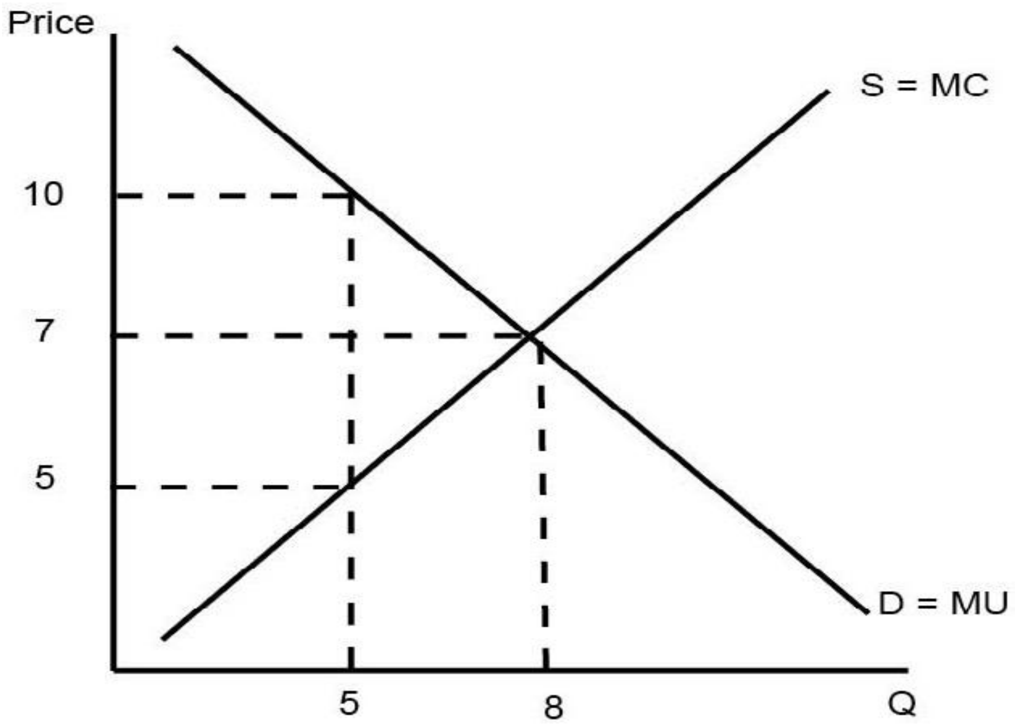


Figure 4.2: Allocative efficiency

Chapter V

DATA AND METHODOLOGY

This section contains information about the research i.e. how and for which purpose the research was carried out, how the data was collected, which variables and determinants were included and which form of statistical procedure was employed.

5.1 Universe of the Study

This research was conducted for the district Swabi in KPK province of Pakistan. Within KPK, Swabi has the biggest area precisely 13,584 hectares are under tobacco farming. In KPK it accounts for 37 percent of total region used for tobacco farming. Swabi is the largest producer of tobacco crop in terms of value (value of crop produced in 2015).

5.2 Sampling Techniques and Sample Size

To begin with, district Swabi was chosen as it is one of the major tobacco producing region of Khyber Pakhtunkhwa and it leads in the value of crops produced in contrast to other districts. District Swabi comprises of four tehsils namely tehsil Swabi, tehsil Topi, tehsil Lahore and tehsil Razzar. Secondly, Tehsil razzar and tehsil Swabi is selected purposively because the number of tobacco growers in tehsil Swabi and tehsil razzar are greater than the other two districts. Thirdly, four villages namely Manery, Yarhussain, Slaim khan and Kernel Sher Kali have been chosen through random sampling technique. Lastly, a random sample of 209 farmers is allocated to these four villages by using proportional allocation sampling procedure based on the following rule (Cochran, 1977). [2]

$$\mathbf{r_i = n^*(T_i/T)} \qquad \mathbf{(5)}$$

[2] The sample of 210 tobacco growers is selected using the total number of tobacco growers in the four villages (990), confidence level of 95% and confidence interval of 6%.

whereby; $\mathbf{r_i}$ stands for the number of sampled respondents in the ith village, **n** is the total sample size, $\mathbf{T_i}$ represents total number of tobacco growers in the ith village and **T** is the population of tobacco producers in targeted area. This sample of 209 included both the farmers who are registered with the Farmer Field School and the ones who are not.

Table 5.1: Population and sample size of tobacco producers in Swabi

District	Tehsile	Village	No. of tobacco growers	Size of Sample
Swabi	Razzar	Yarhussain	300	64
		Kernel sher kali	245	52
	Swabi	Maneri	245	52
		Salim khan	200	41
Total			990	209

Source: Govt. Khyber Pakhtunkhwa, 2016

5.3 Data Collection

In the underlying study primary data was employed. The unit of primary data was tobacco producers. Data collection was done through a well designed questionnaire and the questionnaire is attached in the appendix of the study. Sampled growers were interviewed personally at their farm. Farmers were first taken into confidence that the required information is needed purely for research purpose and to get correct accurate data for reliable estimates.

5.4 Data and Variable

In this section the data and variables are discussed. Table 5.2 shows the inputs and output of tobacco as well as determinants of technical efficiency.

Table 5.2: Description of Variables

Panel A: Inputs

S.No	Variables	Description
1	Seeds	Seeds in gm per acre
2	Labor	Labor Man days used per acre
3	Irrigation	No. of irrigation for whole season
4	Pesticides	Amount of chemicals used in ML
5	Fertilizer	Amount of fertilizer (Kg)
6	FYM	Amount of Farm Yard Manure (Kg)
7	Tractor	Number of tractor Hours per acre

Panel B: Determinants

S. NO	Determinants	Description
1	AGE	Farmers age in years
2	EXP	Farmers experience in years
3	EDU	Education level of the Farmers in years
4	FFS	Farmer Field School (Yes / No)
5	TS	Tenure status
6	EXV	number of extension visit
7	Occ	Occupation of farmer if other (Yes/ No)
8	Credit	Access to credit (Yes/ No)
9	Income	Income of farmer per month
10	Land	Land of farmer per acre

Panel C: Output

1	Tobacco per kg

5.5 Econometric Methodology

5.5.1 Methodology for Efficiency Measurement

Farrell (1957) introduced the way to estimate frontier production function. Its theoretical foundation was given by Meeusen and Broeck (1977) & Aigner *et al.* (1977). The present study utilized the stochastic frontier model that has been used in previous studies like Timmer, 1971; Greene, 1990; Iinuma *et al.*, 1999; Fousekis and Klonaris, 2003 and Binam *et al.*, 2004.

For the estimation of technical efficiency, following stochastic frontier production function of Cobb-Douglas form was used:

$Ln\ Y_i = \beta_0 + Ln\beta_1$ (seeds) + $Ln\beta_2$ (Labor) + $Ln\beta_3$ (irrigation) + $Ln\beta_4$ (Pesticides) +$Ln\beta_5$ (Fertilizer) + $Ln\beta_6$ (FYM) + $Ln\beta_7$ (Tractor) +D1 FFS + ϵ_i

Where,

Seed = No of seed/acre

Labor = Labor days used/acre

Irrigation = No. of irrigation for whole season

Pesticides = Pesticides used in ML/ acre

Fertilizer = Amount of fertilizer (Kg/acre)

FYM = Amount of Farm Yard Manure (Kg/acre)

Tractor = No of tractor Hours/acre

In order to investigate the factors that contribute to technical inefficiency, the stochastic frontier and inefficiency model was estimated mutually through the use of one stage maximum likelihood estimation (MLE) method utilizing frontier version 4.1 (Coelli and Battese, 1996) as follows:

$$\mu_i = \alpha_0 + \alpha_1(X_i) + \omega_i$$

whereby X_i is a vector of variables consisting of the Age of Farmers (Years), Farmers' Experience (years), Farmers education level (years), Tenurial status, number of extension visit, Land of farmer, Income of farmer, Occupation of farmer and access to credit.

5.5.2 Farmer Field School and Efficiency

5.5.2.1 OLS and Propensity Score Matching

OLS is the basic regression design. However there are few issues with it for instance biasness of omitted variable. The coefficient will be biased if relevant variables are omitted. Secondly, controlling for variables that are affected by the variable of interest will produce prejudiced coefficient. Hence instead of doing an OLS regression, matching methods can be used. Matching method is desirable to be used when the variable takes on only two values. OLS and matching method are similar if the treatment effects are constant. However if treatment effects are distinct, they will vary as distinct weighting schemes are employed. OLS is efficient under the assumption that the treatment effect is constant, so observations are weighed by the conditional variance of the treatment status. The treatment group and the control groups may be very different in matching and OLS. Since there are imbalances between the groups hence logistic regression is employed to cater for these discrepancies. The main advantage of a logistic regression is that it can be used to control for many variables at once. An additional method to control for imbalances is the propensity score, which is the conditional probability of a subject's receiving a particular treatment given the set of variables. For calculation of a propensity score, the variables are used in a logistic regression to predict the exposure of interest, without the inclusion of outcome.

5.5.2.2 Propensity Score Matching

A program that is implemented to some groups while other groups receive no treatment is known as treatment evaluation. Unlike the control group, the treated group receives the treatment. The objective of treatment evaluation is to evaluate the effect of a treatment on the treated group while using control group as a benchmark. There are 2 types of studies, first one is controlled experiments where assignment into treated and control groups is random. However we usually have observational studies where the assignment into treated and control groups is not random i.e. some individuals decided to participate in the program while others don't. Since people who participate in the program are different than those who did not hence their outcomes cannot be directly compared. Thus it is necessary to first match them as much as possible in order to compare their outcomes. This leads us to the propensity score matching methodology.

5.5.2.3 Steps in Propensity Score Matching

1) Firstly the observations are assigned into two groups: the treated group that received the treatment & the control group that has not. In our study those who are registered in the FFS program are the treated group and those who are not registered with the FFS program are the control group.

Treatment D is a binary variable that depicts if the agent/observation got the treatment or not. In our case it is the treatment in FFS.

For treated observations D=1 and for control observations D=0. We can estimate a binary outcome model once the individuals have been divided into two groups. That is typically a probit/logit model.

2) A probit/logit model is estimated in order to assign the propensity of observations into the treated group. x denotes the variables that affects the probability of being assigned into the treated group.

$$p(x) = probab(D = 1/x) = E(D/x)$$

The propensity score model is exactly a probit model and we want to get the predicted probabilities out of this model (P hat) or the conditional probabilities E(D/x) of receiving a treatment i.e. being in the FFS program given their pre-treatment characteristics x.

Unfortunately we do not have data on pre-treatment characteristics. Hence we have to make a strong assumption that the treatment has not affected the x variables.

3) Once the probit model is estimated we will have predicted probabilities. We will lump them up into a propensity score and now we would be matching on that propensity score.

4) Observations from treated and control groups based on their propensity scores are matched. The aim is to locate a match for the treated group and not the control group.
5) Several matching methods are available such as kernel, nearest neighbor, radius stratification, inverse probability weight and inverse probability regression adjustment.
6) Once the match has been found next step is to calculate the treatment effects i.e. compare the outcomes y between the treated and control groups.

There are various types of propensity score matching such Kernel, Nearest Neighbor Matching, Radius and Stratification or Interval Matching, Inverse-probability Weights and Inverse-probability Weight Regression Adjustment. In case of Kernel Matching for each observation of treated group, all the observations of control group are used whereby they are weighed. In other words, the closer it is to the propensity score the higher the weight and vice versa. In contrast, the Nearest Neighbor Matching uses each observation that has been treated to choose a control observation that has the closest x. Another one is Radius Matching whereby a radius is formed around the observation in the control group and all those observations in the radius are used for matching. Lastly, the Stratification or Interval Matching uses intervals or blocks of propensity scores to compare the outcomes. In it the matching is restricted based on the common range of propensity scores.

5.5.2.4 Treatment Effects

Average Treatment Effect (ATE)

The variation amid the outcome of control and treated observations is called the Average Treatment Effect (ATE).

$$\Delta = y_1 - y_0$$

$$ATE = E(\Delta) = E(y_1/x, D = 1) - E(y_0/x, D = 0)$$

ATE is fine for random experiments but in observational studies it may be biased if treated and control observations differ.

Average Treatment Effect on the Treated (ATET)

ATET is the discrepancy between the outcome of treated and the outcomes of the treated observations had they not been treated.

$$ATET = E(\Delta/D = 1) = E(y_1/x, D = 1) - E(y_0/x, D = 1)$$

The 2^{nd} term is a conditional hence it is unobservable and therefore needs to be estimated.

Propensity Score Method

After matching on propensity scores, treated & control observations' outcomes are comparable.

$$ATET = E(\Delta/p(x), D = 1) - E(y_0/p(x), D = 0)$$

Empirical estimation

Treated observation is matched with control observations; their outcomes y_0 are weighed by *w*.

Assumptions

There are several assumptions, firstly it is assumed that there are no general equilibrium effects i.e. treatment does not indirectly affect the control observations. Secondly, the conditional independence assumption implies that for random experiments, the outcomes are independent of treatment. While for studies based on observations, the outcomes are free of treatment, conditional on x. Thirdly, the unconfoundedness supposition asserts on the conditional independence of the control group outcome and treatment. Moreover the overlap or matching assumption propagates that for each x, there are treated & control observations. Thus a matched control observation with similar x is there for each treated observation. Lastly, the balancing condition that is testable implies that given the propensity score is same, the assignment to treatment is free of the characteristics of x.

5.6 Descriptive Statistics

Table 5.3 below shows the descriptive statistics of variables that was used in stochastic frontier Cobb-Douglas production function and propensity score matching. The mean output value was 5441.38 kg in study area with standard deviation of 3571.99 while the mean value of log of output is 8.4336 with standard deviation of 0.5611 and that of the mean efficiency of tobacco farmers were 0.8070 with standard deviation of 0.92045. The average ages of the farmers were 50 year while the average educations of the farmers were 3 year. Experience role cannot be underestimated the average experience of the farmer were 21 year. The average land of the farmer in study area was 4 acre.

Table 5.3: Descriptive Statistics

Variables	Observations	Mean
Panel A:Output		
YY	209	5441.38 (3571.99)
LYY	209	8.433 (0.5611)
TE	209	0.8070 (0.9204)
Panel B: Inputs		
Labor days	209	60.29 (17.024)
Seed (KG)	209	108.50 (109.91)
Tractor Hours	209	22.349 (12.353)
Irrigation number	209	13.229 (2.0083)
Urea(KG)	209	134.22 (263.40)
DAP(KG)	209	230.98 (154.05)
NPK(KG)	209	153.34 (224.72)
SOP(KG)	209	25.74 (46.47)
FYM(KG)	209	4868.9 (2728.82)
PESTICIDE(LITERS)	209	65.93 (38.96)
Panel C:Determinants		
Age	209	50.467 (7.3767)
Education	209	3.071 (3.272)
Experience	209	21.669 (8.8383)
Occupation	209	0.1004 (0.3013)
Land	209	4.933 (2.796)
TS	209	0.2918 (0.4557)
Access to Credit	209	0.2583 (0.4387)
Monthly Income	209	21401.44 (6721.78)

Furthermore loan taken main occupation of farmer and family or hired labor also seen in the study. The input utilized in the tobacco production by the study sample include 61 Labor man days approximately, 22 tractor hours, 13 times irrigation, 134.22 kg of urea, 230.98 kg DAP. 153.34 NPK, 25.74 kg SOP, 4868.9 kg FYM and 35.93 liters pesticides. The crop's input used by the FFS and Non FFS Farmers are also discussed in Table 5.3.

Chapter VI

RESULTS AND DISCUSSION

This chapter of results and discussion presents the finding of our study, which includes the estimation of Cobb-Douglas form of the stochastic frontier production function, estimation of cost and revenue of tobacco growers, estimation of average technical efficiency and inefficiency of sample respondents using maximum likelihood statistical procedure and the examination of the impact of farmer field school on technical efficiency of tobacco growers using propensity score matching.

Table 6.1: Maximum likelihood estimates of stochastic production frontier of tobacco crop

Variables	Coefficient
Ln Total Pesticide	0.5246*** (0.0964)
Ln Total Labor	0.3992** (0.1995)
Ln Total Tractor Hours	0.2198*** (0.0631)
Ln Total Seed	0.0510*** (0.0186)
Ln Total Fertilizer	-0.5386 (0.0331)
Ln Total Fertilizer^2	0.0247 (0.0566)
Ln Total Irrigation	1.5818 (1.6280)
Ln Total Irrigation^2	-0.4218 (0.3415)
Sigma-U	0.1696 (0.2708)
Sigma-V	0.2859 (0.5088)
Constant	6.1312 (0.1688)

Note: ***and ** denotes significance at 1 percent and 5 percent level of significance.

We begin our analysis with the maximum likelihood estimates of the stochastic production frontier of tobacco crop. The results are presented in table 6.1. It is evident that pesticide, labor, tractor hours and seed quantity are statistically significant at 1 and 5 percent levels and thus are important determinants of tobacco production. The coefficient of pesticide shows that as pesticide use increases by 1 percent then on average the tobacco production increases by 0.5292 percent. Various studies have shown similar results such as Hance (1981) and Saddozai *et al.* (2015). Similarly, as the total labor increases by 1 percent, the tobacco production increases by 0.4047 percent on average. Other studies have concluded similar findings like Ali and Khan (2014) and Peng and Kong (2015). Moreover, a percent increase in tractor hours increases the tobacco production by 0.2106 percent. Salam (1987) and Ali and Khan (2014) found similar results. Furthermore, as the total seed use increases by 1 percent then on average the tobacco production increases by 0.0510 percent. This result substantiates the findings of Sibiko *et al.* (2013). In contrast the fertilizer and irrigation have no statistically significant impact on tobacco production. The reason being that both the groups use similar kind of fertilizer and the canal irrigation hence no variation in the tobacco production. Following the stochastic frontier regression, efficiency score for the whole sample was generated with minimum value of 0.5083, maximum value of 0.9604 and with mean value of 0.8070.

Table 6.2 shows the simple regression of output, log of output and efficiency on other independent variables. It is evident from Model 1 that FFS affects tobacco output in the absence of control variables. The FFS coefficient is statistically significant at 1 percent level of significance which implies that those who are registered with FFS have 2284.17 KG higher output than those who are not registered in FFS. In order to avoid the specification bias, other determinants have also been included in model 2. The results of Model 2 indicate that the effect of FFS on tobacco output decreases in magnitude when controlled for other determinants. The land size and occupation are positive and significant at 1 percent significance level. The positive impact of land size and occupation could be due to no of economies of scale and learning by doing respectively, whereas monthly income is significant at 5 percent level. The R-square shows that 88 percent of the variation in output is caused by all the determinants.

Table 6.2: Results of Simple regression

Variables	Output		Log of Output		Efficiency	
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
FFS	2284.17***	1731.2***	0.4115***	0.3300***	0.1258***	0.1243***
	(476.70)	(176.05)	(0.0735)	(0.3031)	(0.0095)	(0.0099)
Age		-1.7638		0.0032		-0.00007
		(16.923)		(0.0029)		(0.0009)
Education		36.03		-0.0048		0.0004
		(31.15)		(0.0051)		(0.0017)
Experience		13.73		-0.0006		0.0009
		(13.70)		(0.0023)		(0.0007)
Occupation		690.14**		0.1183**		0.0043
		(283.52)		(0.0488)		(0.0160)
Land		1096.8***		0.1603***		-0.0010
		(39.04)		(0.0067)		(0.0022)
Tenure Status		-153.80		0.0115		-0.0085
		(189.03)		(0.0325)		(0.0107)
Access to Credit		632.65***		0.0941**		0.0071
		(224.77)		(0.0387)		(0.0127)
Monthly Income		-0.030**		-3.04e-07		-1.21e-06
		(0.016)		(2.77e-06)		(9.12e-07)
R-Square	0.0998	0.8897	0.1313	0.8675	0.4565	0.4677
Adj R-Square	0.0995	0.8847	0.1271	0.8615	0.4539	0.4436
Observations	209	209	209	209	209	209

Note: *****, ****and * indicates significance at 1, 5 and 10 percent level of significance.

Similarly, Model 3 and 4 show the result of log of output which is almost similar to the results of model 1 and model 2 except that the monthly income is insignificant in model 4. The coefficient of FFS in Model 3 is 0.4115 and is statistically significant at 1 percent level in the absence of other control variables. While it’s magnitude reduces in Model 4 when controlled for other determinants. The R-square of Model 3 indicates that 13 percent variation in log of output is caused by the FFS. However, the R-square of Model 4 shows that 86 percent change in log of output is caused due to the determinants which show goodness of fit of the Model.

The decrease in the FFS coefficient in Model 2 and 4 is an indication that Models 1 and 3 overestimated the impact of FFS on tobacco output. Lastly, in Model 5 and Model 6 FFS significantly affects technical efficiency whereas rest of the determinants are insignificant. The R-square and adjusted R-square for these Models are 45 percent and 46 percent respectively which show that the Model is a good fit.

Table 6.3: Test of Means for Unmatched Samples between Treatment and Control Groups

Variables	Treatment	Control	Difference
Output	6392.21	4108.04	2284.16*
	(362.54)	(244.86)	(476.70)
Log of Output	8.6049	8.1934	0.4115*
	(0.0494)	(0.0527)	(0.0735)
Technical Efficiency	0.85	0.73	0.125***
	(0.004)	(0.009)	(0.09)
Age	50.46	49.643	0.823
	(0.724)	(0.688)	(1.036)
Education	2.8196	3.4252	-0.605
	(0.282)	0.371)	(0.458)
Experience	21.63	21.72	-0.092
	(0.759)	(1.016)	(1.343)
Access to Credit	0.3032	0.1954	0.1078*
	(0.041)	(0.042)	(0.061)
Occupation of	0.0655	0.1494	-0.0838*
Farmer	(0.225)	(0.038)	(0.041)
Monthly Income	20983.6	21987.3	-1003.75
	(585.9)	(756.2)	(942.9)
Tenure Status	0.2540	0.3448	-0.0907*
	(0.039)	(0.051)	(0.063)
Land of Farmer	5.1311	4.6551	0.4759
	(0.267)	(0.273)	(0.392)
Observation	122	87	

Note: *** and * denotes significance at 1 and 10 percent respectively.

Table 6.3 shows the differences in the outcome and control variables of the treated and control group. It is evident that the output of the treated group is greater than the control group by 2284.16 Kg and it is statistically significant at 10 percent. On the same lines, log of output of treated group is greater than the control group by 0.4115 percent and it is significant at 10 percent. Likewise, technical efficiency of the treated group exceeds that of the control group by 12.5 percent on average and the difference is statistically significant at 1 percent. Moreover access to credit, occupation of farmer and Tenure status are significantly different between the two groups. This result is in accordance with the findings of Udo and Etim (2009), Ajewole and Folayan (2008), Kibara (2005) and Hassan *et al.* (2016). These determinants have lower average values for the treated group as compared to control group. Since the differences between the control and treated groups are significant, we move towards propensity score matching in order to eliminate those differences. Thus to determine the propensity score, probit regression is run and the optimal blocks chosen by the system is five. The characteristics of the control and treated group are the same within these five blocks. The balancing property needs to be satisfied in order to use the matching methods. Since the balancing condition is satisfied in our case hence we proceed towards calculation of propensity matching score using various matching methods. However, before discussing those results, a look at the results of probit regression is desirable. Table 6.4 shows the results of the probit regression. It is evident that occupation, access to credit and tenure status is statistically significant at 5 and 10 percent respectively. The occupation is defined by a dummy variable that takes the value 1 if the sole occupation is farming and 0 otherwise. The coefficient of occupation shows that the probability of a farmer getting registered in FFS reduces by 0.5839 if their sole occupation is farming. The reason being that those who are solely farmers have specialized in their field overtime and thus are likely to become more specialized in their tasks and hence require less guidance to perform efficient farming activities. Consequently, their likelihood of enrolling in the FFS program is reduced.

Similarly, the probability of a farmer being registered in FFS increases by 0.4078 if he has access to credit. On the same lines, the chance of a farmer being enrolled in FFS decreases by 0.3420 if he owns the land. This could be because of the prejudiced mind set of the farmers who think that their occupation has been granted to them by their ancestors and they need no third party intervention (such as FFS enrollment).

Table 6.4: Results of Probit Regression

Variables	**Coefficient**
Age	0.0116
	(0.0188)
Education	-0.0106
	(0.0324)
Experience	-0.0108
	(0.0145)
Land of farmer	0.0236
	(0.0427)
Occupation	-0.5839**
	(0.2978)
Access to Credit	0.4078*
	(0.2420)
Tenure Status	-0.3420*
	(0.1970)
Monthly Income	-0.00002
	(0.00001)

Note: ** and * denotes significance at 5 and 10 percent respectively.

Table 6.5: Techniques for matching score in case of Output and log of Output

Matching Techniques	**Output(Y)**	**Log of Output(LY)**
	ATT	**ATT**
Nearest Neighbor Matching	2141.55***	0.388***
	(538.79)	(0.098)
Radius Matching	2324.88***	0.420***
	(453.65)	(0.077)
Kernel Matching	2081.02***	0.375***
	(433.28)	(0.074)
Stratification Method	1734.53***	0.328***
	(461.23)	(0.081)
Inverse-probability weights(ipw)	1786.64***	0.3319
	(203.47)	(0.351)
IPW Regression Adjustment	1818.16***	0.3284
	(213.37)	(0.374)

Note: *** denotes significance at 1 percent level of significance.

Table 6.5 shows the matching score of tobacco farmers in case of output and log of output on the basis of several characteristics using different techniques. This indicates that with these similar characteristics there is a huge difference in output of those farmers which are not registered in Farmer Field School. In case of Nearest Neighbor Matching the farmers who join farmer field school produce 2141.55 KG more than those farmers which are not in the farmer field school. Similarly if we see the radius matching, the output of treatment group is 2324.88 KG more than that of control group. While Kernel Matching shows that the registered farmers output is 2081.88 KG higher than non-registered farmers in farmer field school. Furthermore table 6.5 shows that the output with respect to Stratification, Inverse Probability Weights (IPW) and IPW Regression Adjustment method is lower than the first three techniques but higher than that of non-registered farmers. These results are statistically significant at 1 percent. Additionally table 6.5 also shows the result of the case of log of output which shows that the registered farmers produce 38 percent more than non-registered farmers if we match through nearest neighbor. Similarly the difference is statistically significant at 1 percent in case of first four matching techniques which implies that the output of registered farmers is higher than the non-registered farmers. However the difference in the log of output is statistically insignificant in case of the last two matching methods (see Table 6.5).

Table 6.6 shows the different matching technique effects in case of efficiency which shows that how the registered farmers are more efficient than the non-registered farmers. The Nearest Neighbor Matching technique reveals that the registered farmers in Farmer Field School are 14% more efficient than that of non-registered farmers. While in case of other five techniques it is less than that of Nearest Neighbor Matching which is 12 percent more efficient than non-registered farmers in all six techniques. These findings are statistically significant at 1 percent respectively. Nonetheless, the difference remains insignificant under the Inverse-probability weights (IPW) method. Despite the matching of the control and treated group, the difference remains in the technical efficiency and tobacco production between the two groups.

Table 6.6: Techniques for matching score in case of Efficiency

Matching Techniques	**Technical Efficiency**
	ATT
Nearest Neighbor Matching	0.147*** (0.015)
Radius Matching	0.126*** (0.011)
Kernel Matching	0.126*** (0.012)
Stratification Method	0.128*** (0.012)
Inverse-probability weights(IPW)	0.1251 (0.1255)
IPW Regression Adjustment (IPWRA)	0.1253*** (0.0122)

Note: *** denotes significance at 1 percent level of significance

This difference in the output and efficiency between the two groups is purely due to treatment (FFS). An important question that arises that what are the potential channels through which FFS affect efficiency and output. One of the most important channel is the extension visit under FFS that significantly affects the efficiency and output of tobacco. Extension visits refer to the visits to field made by group of experts who guide the farmers to enhance their skills and efficiency. It includes the monitoring of the tobacco nurseries, providing appropriate instructions regarding tobacco cultivation and the solutions to the problems faced by the farmers (such as the use of fertilizers, pesticides, seeds, irrigation, harvesting, picking and plucking the leaves etc.) The extension visit range from 7 to 15 times in whole season. Thus the extension visit has been included as an important determinant in the model. It is defined by the dummy variable which takes the value of 1 for a farmer when at least one extension visit was made and 0 otherwise. In Table 6.7, we explain the impact of extension visits on the efficiency score. With the inclusion of the variable, the remaining determinants become insignificant except for experience. However the coefficient of experience is economically negligible since its magnitude is very small. The coefficient is 0.12 and is statistically significant at 1 percent significance level. Hence extension visits accounts for almost all the efficiency differences between both the groups.

Table 6.7: Source of efficiency differences between control and treated group

Variables	**Coefficient**
Extension Visit	0.1192***
	(0.0107)
Age	-0.0013
	(0.0010)
Education	-0.0005
	(0.0018)
Experience	0.0020**
	(0.0008)
Land of Farmer	-0.0018
	(0.0023)
Occupation	0.0128
	(0.0172)
Access to Credit	0.0048
	(0.0135)
Monthly Income	-7.40e-07
	(9.80e-07)
Tenure Status	-0.0074
	(0.0114)

Note: *** and ** denotes significance at 1 and 5 percent respectively.

From the above results it can be concluded that FFS plays a significant role in enhancing the efficiency of tobacco farmers in the study area. The efficiency of the treated group was found to be greater than that of the control group. In other words the tobacco production of the treated group have been found significantly greater than that of the control group. This difference in the efficiency is attributable to the extension visit which is the part of the FFS programme.

Chapter VII

CONCLUSION

This study was conducted for the District Swabi of Khyber Pakhtunkhwa, Pakistan. The main theme of the underlying research was to estimate the technical efficiency of tobacco production. Furthermore it aimed to identify the factors that influence the technical inefficiency and the impact of Farmer Field School (FFS) on technical efficiency. Maximum likelihood estimation technique was used for the stochastic frontier Cobb-Douglas production function to estimate the technical efficiency.

In order to achieve the objective of the study a sample of 209 tobacco growers were interviewed through a well-designed questionnaire. The regression analysis of tobacco yield shows that seed quantity, farm yard manure, Total Tractor hours, Labor man days, total pesticides and total seed quantity significantly affects tobacco production. The range of technical efficiency on the whole was 0.5083 to 0.9604 with mean value of 0.8070 which implies that significant improvement is still possible in the technical efficiency of tobacco production. On the other hand, the Technical Efficiency range for FFS farmers is 0.611 to 0.9604 with a mean of 0.80 and for Non-FFS farmers is 0.5083 to 0.9415 with a mean of 0.73.

The means difference between treated and control group as well as the probit regression analysis revealed that occupation, tenure status and access to credit affect the likelihood of the farmer being registered in FFS. Moreover different matching techniques were used in order to estimate the propensity score. It was found that the extension visits which is a source of knowledge dissemination among the farmers, greatly contributed in enhancing the technical efficiency. In contrast, age, education, land size, tenure status, occupation of farmer, monthly income and access to credit were found to have no impact on the efficiency difference of the tobacco growers. The finding of the underlying study is consistent with the conclusions of Rola *et al.* (2002) who found that the FFS farmers have advantage of knowledge as compared to non-FFS farmers.

There are several reasons why the farmers decide to join the FFS. Firstly, FFS makes the farming easy since the instructions and inputs are provided to the farmers. Secondly, it also deals with the catastrophic/uncertain events and provides security/insurance to the farmers in case of unforeseen events. However, some farmers choose not to join the FFS programme mainly due to two reasons. Firstly, the procedure to join the FFS is cumbersome requiring individuals to que in line for a long time thus inflicting time cost on the individuals. Secondly, many farmers consider their occupation to be sacred and take a great pride in it. Hence they do not want a third party to interfere in their farming. Thus this prejudice causes many to not enroll in FFS. But since FFS has been found to be effective in promoting the technical efficiency of tobacco production in the study area, thus the study suggests that the government should promote the FFS programme. In other words, the farmers should be encouraged to register in FFS. This can be achieved by making the programme more accessible by simplifying the cumbersome procedures. Moreover, workshops and seminars should be conducted to enhance the exposure of the farmers and ease their mindsets to remove the prejudice of the farmers regarding the third-party interference. In addition, the FFS programme should be made part of the agriculture policy in the province. The improvements in the knowledge on scientific cultivation of tobacco growers through their participation in field days, trainings and contacts with extension workers can help in achieving higher productivity through correct adoption of the recommended production technologies and thereby high gross income. Moreover, the FFS facilitator and coordinator should be more skilled and practical oriented so that farmers face no problems. Furthermore, the FFS approach needs to be carried out under the supervision of a single institution which would further enhance the proper implementation of the programme.

The current study pinpoints some potential areas for future research. For example, one of the limitations of the study is that it does not cover the social cost of inclusion into FFS. This was beyond the scope of current study. However, future research can include this into analysis. Moreover, since the underlying study only focused on technical efficiency of tobacco in the study area, there is a scope for future research that focuses on allocative efficiency since it would give more insight into the efficiency differences. Furthermore, it would be interesting if the efficiency of farmers could be studied overtime to see how it has changed.

REFERENCES

Abdullah, H.M. and Rahman, M.M. 2015. Initiating rain water harvest technology for climate change induced drought resilient agriculture: scopes and challenges in Bangladesh. *Journal of Agriculture and Environment for International Development.* 109 (2). pp. 189-208

Abedullah, Bakhsh, K. and Bashir, A. 2006.Technical Efficiency and its Determinants in Potato Production: Evidence from Punjab, Pakistan. *The Lahore Journal of Economics*, pp. 1-22

Agridape .2003. Les champs-écoles à l'oeuvre! Agripade – Revue sur l'agriculture durable à faibles apports externs. 19(1), pp. 1-36.

Aigner, D.J., Lovell, C.A.K and Schmidt, P. J. 1977. Formulation and Estimation of Stochastic Frontier Production Function Models. *Journal of Econometrics*. 6, pp.21-37.

Ali, S. and M. Khan. 2014. Technical efficiency of wheat production in District Peshawar, Khyber Pakhtunkhwa, Pakistan. Sarhad J. Agric. 30(4): 433-441

Areerat, T., Hiroshi, K., Kamol, N., and Koh-en, Y. 2012. Economic efficiency of broiler farms in Thailand: Data envelopment analysis approach. *British Journal of Economics, Finance and Management Sciences*.

Azam, Q. T., and Evenson, R. 1990. Agricultural research productivity in Pakistan. *Draft paper, Islamabad: Pakistan Agricultural Research Council and Economic Growth Center, Yale University*.

Azizi, K. and Moghaddasi, R. 2012. Potato Production Efficiency: Evidence from Firoozkuh, Iran: *Middle-East Journal of Scientific Research* 11 (10), pp. 1439-1442.

Bakhsh, K., B. Ahmad, S. Hassan and Z.A. Gill. 2007. An analysis of technical efficiency of growing bitter gourd in Pakistani Punjab. Pak. J. Agri. Sci. 44:350-355.

Baree, M. A. 2012. Measuring Technical Efficiency of Onion (Allium cepa L.) Farms in Bangladesh. *Bangladesh Journal of Agricultural Research*, *37*(1), pp.171-178.

Battese, G. E. and Coelli, T. J. 1995. A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. *Empirical Economics,* 20, pp.325-332.

Binam J.N., Tonye J., Wandji N., Nyambi G. and Akoa M. 2004. Factor Affecting the Technical Efficiency Among Smallholder Farmers in the Slash and Burn Agriculture Zone of Cameron. Food policy, 29(5), pp. 531-545

Braun, Ann R., Graham T., 2000. Integrated Nutrient Management to Attain Sustainable Productivity Increase in East African Farming Systems, Kenya, Nairobi.

Braun, Arnoud R., J. Jiggins, N. Röling, H. Van Den Berg and P. Snijders, 2005. A Global Surveyand Review of Farmer Field School Experiences. Intl Livestock Res Institute, Nairobi.

Buhler, D. D., Liebman, M. and J. J. Obrycki. 2000. Theoretical and practical challenges to an IPM approach to weed management. Weed Sci 48, pp.274-280.

Butt, T. M., Gao, Q., & Hussan, M. Z. Y. 2015. An Analysis of the Effectiveness Farmer Field School (FFS) Approach in Sustainable Rural Livelihood (SRL): The Experience of Punjab-Pakistan. *Agricultural Sciences*, *6*(10), pp.1164.

Charnes, A., Cooper, W.W and Rhodes, E. 1978. Measuring the efficiency of DMUs, European Journal of Operational Research, 2, pp. 429-444

Chigozie, A. 2002. Promoting Sustainable Extension Approaches: Farmer Field School (FFS) and its role in sustainable agricultural development in African. *International Journal of Agriculture and Rural Development*, Vol 3, No 1.

Cochran, W. G. 1977. Sampling Techniques, 3rd Edition. John Wiley and Sons, New York. pp. 37–45.

Coelli, T.J. and Battese, G., 1996, Identification of Factors which Influence the Technical Inefficiency of Indian Farmers, *Australian Journal of Agricultural Economics*, 40, pp. 103-128.

Coelli, T.; Rao, D.S.P. & Battese, G.E. 1998. An introduction to efficiency and productivity analysis. Kluwer Academic, Boston.

Cip-Upward, 2003. Farmer Field Schools: From IPM to Platforms for Learning and Empowerment. International Potato Center – Users' Perspectives With Agricultural Research and Development, Los Banos, Laguna, Phillippines. pp. 87.

Dao, G., & Lewis, P. (2013). Technical efficiency of annual crop farms in northern Vietnam. Working Paper, available at: www. murdoch. edu. au.

David S. 2007. Knowledge Improvement and Social Benefits among STCP Farmer Field School Participants in Cameroon. STCP Working Paper Series 2. International Institute of Tropical Agriculture, Accra, Ghana.

Dilts, R. 2001. From farmers' field schools to community IPM, LEISA Magazine on Low External Input and Sustainable Agriculture, Lessons in scaling-up, published by ILEIA, pp 18-20.

Dipeolu, A. O., & Akinbode, S. O. 2008. Technical, Economic and Allocative Efficiencies of Pepper Production in South-West Nigeria: A Stochastic Frontier Approach. *Journal of Economic and Rural Development*, *17*(1), pp. 24-33.

Donkoh, S. A., Tachega, M., & Amowine, N. 2013. Estimating technical efficiency of tomato production in Northern Ghana. *American Journal of Experimental Agriculture*, *3*(1), pp. 56.

Duveskog, D. and Friis-Hansen, E. 2008. *Farmer Field Schools: a platform for transformative learning in rural Africa.* In "Transformative Learning in Action: Handbook of Practice", edited by Mezirow, J. and Taylor, E., Jossey-Bass Press.

Farrell, M. J. 1957. The measurement of productive efficiency. Journal of the Royal Statistical Society, 120(3), pp. 253–290

Fare, R., Grosskopf, S., Kirkley, J. L., & Squires, D. 2001. Data envelopment analysis (DEA): a framework for assessing capacity in fisheries when data are limited.

Feder, Gershon, Rinku Murgai, and Jaime Quizon. 2004. "Sending Farmers Back to School: An Economic Evaluation of the Farmer Field School (FFS) Extension Approach." *Review of Agricultural Economics* 26(1): pp 45-62.

Feder, G., Murgai, R. and Quizon, J.B., 2004. The acquisition and diffusion of knowledge: The case of pest management training in farmer field schools, Indonesia. *Journal of agricultural economics*, *55*(2), pp. 221-243.

Fliert, E.V.D. and E. Van de Fliert. 1993. Integrated pest management: farmer field schools generate sustainable practices. Wageningen Agric. Univ. Papers. 34(3), pp. 93-103.
Fousekis. D and Klonaris. S. 2003. Technical efficiency determinants for fisheries: a study of trammels netters in Greece. Fisheries Research 63: pp 85-95

Ghura, D. and R. E. Just. 1992. Education, infrastructure and instability in African agriculture: Implications for structural adjustment Programmes. Finance and Economic Development. 1(1), pp. 85-105.

Godtland, E. M., Sadoulet, E., Janvry, A. D., Murgai, R., & Ortiz, O. 2004. The impact of farmer field schools on knowledge and productivity: A study of potato farmers in the Peruvian Andes. *Economic development and cultural change*, *53*(1), pp. 63-92.

Government of Pakistan, 2012. Pakistan Economic Survey, Ministry of Finance, Finance Division, Pak. Secretariat Islamabad.

Government of Pakistan, 2014. Pakistan Economic Survey, Ministry of Finance, Finance Division, Pak. Secretariat Islamabad.

Greene, W. 1990. A Gamma Distributed Stochastic Frontier Model. *Journal of Econometrics*, 46, pp. 141–163.

Habib, M., Zafarullah, M., Iqbal, M., Nawab, K., & Ali, S. 2007. Effect of farmer field schools on sugarcane productivity in Malakand Agency. *Sarhad Journal of Agriculture*, *23*(4), pp.1233.

Hance, R. J. (1981). Effects of pesticides on plant nutrition. In *Residue reviews* (pp. 13-41). Springer New York.

Hasan, M., Imai, K. and Sato, T., (2013), "Impacts of agricultural extension on crop productivity, poverty and vulnerability: Evidence from Uganda*",* (No. DP2012-34).

Hassan.F, Masyhuri.D.D.H.and Adiyoga .W (2016). *"*Journal of Economics and Sustainable Development". Vol.7, No.16.

Heidari, M. D., Omid, M., & Akram, A. 2011. Energy efficiency and econometric analysis of broiler production farms. *Energy*, *36*(11), pp. 6536-6541.

Iinuma, M., Sharma, K.R.and Leung P. 1999. Technical efficiency of carp pond culture in peninsula Malaysia: an application of stochastic production frontier and technical inefficiency model. Aquaculture. pp 199–213.

Iqbal, M., Nawab, K., Sajjad, M. Pervaiz, U. and Ullah, S. 2012. Farmers field schools and rice productivity an empirical analysis of district Malakand. Sarhad J. Agric. 28(1), pp. 143-148

Javed, M. I., Adil, S. A., Javed, M. S. and Hassan, S. 2008. Efficiency analysis of rice-wheat system in Punjab, Pakistan. Pak.J. Agri. Sci. 45(3), pp. 95–100.
Javed, M. I., Adil, S. A., Hassan, S., & Al, A. 2009. An efficiency analysis of Punjab's cotton-wheat system.

Jiggins, J., Governatori, G. and Roggero, P.P. 2005. *Integrated Pest Management for Western Corn Rootworm in Central and Eastern Europe.* GTFS/RER/017/ITA Project. Mid-Term Review, FAO, Rome, Italy.

Jondrow, J., Lovell, C. K., Materov, I. S., and Schmidt, P. 1982.On the estimation of technical inefficiency in the stochastic frontier production function model. *Journal of econometrics*, *19*(2-3), pp 233-238.

Jurgen, H., Chuma, E., Murwira, K and Connolly, M. 2000. Learning together Participatory Extension. A Guide to an Approach Development in Harare: AGRITEX

Khan, M. A., Iqbal, M., and Saeed, I. 2005. Sustainable Cotton Production through Skill Development among Farmers: Evidence from Khairpur District of Sindh, Pakistan [with Comments]. *The Pakistan Development Review*, pp.695-716.

Khan, H. and Saeed, I. 2011. Measurement of Technical, Allocative and Economic Efficiency of Tomato Farms in Northren Pakistan, Internation Conference on Management, Economics and Social Sciences.

Khatam, A., Muhammad, S., Chaudhry, K. M., Khan, M. Z., and Gill, I. A. 2013. Analysis of farmer field schools as a tool of capacity building for resource poor farmers in Khyber Pakhtunkhwa, Pakistan. *Sarhad J. Agric*, *29*(1), pp. 139-143.

Kibaara, B. W. (2005). Technical efficiency in Kenyan's maize production: An application of the stochastic frontier approach (Doctoral dissertation, Colorado State University).

Kopp, R. J., and.Diewert, W. E. 1982.The Decomposition of Frontier Cost Function Deviations into Measures of Technical and Allocative Efficiency. *Journal of Econometrics* 19, pp. 31

Kumbhakar. S.C. and Sarkar, S. 2004. Deregulation, Ownership and Efficiency in Indian Banking: An application of Stochastic Frontier Analysis. IGIDD working paper 9, pp.331.

Leisa, 2003a. *Learning with Farmer Field Schools.* LEISA – Magazine on Low External Input and Sustainable Agriculture. 19-1, pp. 1-36.

Leisa, 2003b. *Aprendiendo con las* ECAs. LEISA – Revista de Agorecología. 19-1, pp. 1-87.

Luqman, M., Javed, A. and Asghar, N. 2005. Impact of Administrative Changes on the Working Efficiency of Extension Field Staff after Decentralization in the Punjab, Pakistan. J. Agric. Soc. Sci., 1, pp. 223–6

Mahjoor, A. A. 2013. Technical, allocative and economic efficiencies of broiler farms in Fars Province, Iran: A data envelopment analysis (DEA) approach. *World Applied Sciences Journal*, *21*(10), pp. 1427-1435.

Meeusen, W. and Van den Broeck, J. 1977. Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. *International Economic Review*, 18, pp. 435–444.

Mohammadi, A., & Omid, M. 2010. Economical analysis and relation between energy inputs and yield of greenhouse cucumber production in Iran. *Applied Energy*, *87*(1), pp. 191-196.

Murthy, D. S., Sudha, M., Hegde, M. R., & Dakshinamoorthy, V. 2009. Technical efficiency and its determinants in tomato production in Karnataka, India: data envelopment analysis (DEA) approach. *Agricultural Economics Research Review*, *22*(2), pp. 215-224.

Mwaura, F. 2014. Effect of farmer group membership on agricultural technology adoption and crop productivity in Uganda. *African Crop Science* Journal, *22*, pp. 917-927.

Omar, M. A. E. 2014. Technical and Economic Efficiency for Broiler Farms in Egypt. Application of Data Envelopment Analysis (DEA). *Global Veterinaria* 12 (5), pp. 588-593

O.C. Ajewole and J.A. Folayan , 2008. Stochastic Frontier Analysis of Technical Efficiency in Dry Season Leaf Vegetable Production among Smallholders in Ekiti State, Nigeria. Agricultural Journal, 3: 252-257

Okezie, C. A. and Okoye, B. C. 2006. Determination of technical efficiency among Egg plant (Solanum sp.) Farmers Using the Stochastic frontier model in Isialangwa area of Abia State. *Nigeria. Agricultural Journal*, *1*(3), pp. 119-122.

Ooi, P.A.C. 2003. *IPM in Cotton: Lessons from Rice IPM.* In: Mew, T.W., D.S. Brar, S. Peng, D. Dawe, and B. Hardy (Eds.). Rice Sciences: Innovations and Impact for Livelihood. IRRI, Los Banos, Philippines. pp. 919-926.

Peng, Y. L., & Kong, R. (2015). Technical Efficiency on Flue-cured Tobacco Productin and Its Hierarchical Influencing Factors: An Empirical Study in China. International Association of Agricultural Economists

Pingali, P. L., Moya, P. F and Velasco, L. E. 1990. The Post-green revolution blues in Asian rice production - the diminished gap between experiment station and farmer yields. Social Science Division Paper no. 90-01.

Pingali, P. L. and Heisey, P. W. 1997. Cereal crop productivity in developing countries: Past trends and future prospects. Economics working papers.

Pontius, J., Diltis, R. and Bartlett, A. 2002. From farmer field school to community IPM: Ten years of IPM training in Asia. FAO, Bangkok.

R. E. A. Khan and Shoukat, G. 2013. Technical Efficiency of Tomato Production: A Case Study of District Peshawar (Pakistan). *World Applied Sciences Journal* 28 (10), pp. 1389-1392.

Rola, A., Jamias, S. and Quizon. J. (2002). Do Farmer Field School Graduates Retain and Share what they Learn? An Investigation in Iloilo, Philippines, *Journal of International Agricultural and Extension Education* **9**(1):65-76.

Saddozai, K. N., Saboor, A., Khan, M. A., Jan, D., & Ali, G. 2013. Analyzing the impact of Farmer Field School on Technical Efficiency of Cotton Growers in Southern districts of Punjab-Pakistan: Stochastic Production Frontier Approach. *Sarhad J. Agric*, 29(2), pp.291-298.

Salam, A. (1981). Farm tractorization, fertilizer use and productivity of Mexican wheat in Pakistan. *The Pakistan Development Review*, 323-345.

Savonen C. (1997). Soil microorganisms object of new OSU service. Good Fruit Grower.

Schmidt, P. and Lovell, C.A.K.1979. Estimating technical and allocative inefficiency relative to stochastic production and cost frontiers, Journal of Econometrics 9, pp. 343-366.

Shehu, J. F., Iyortyer, J. T., Mshelia, S. I., & Jongur, A. A. U. 2010. Determinants of yam production and technical efficiency among yam farmers in Benue State, Nigeria. *Journal of social science*, *24*(2), pp. 143-148.

Sherman, H.D., and Zhu, J. 2013. Analyzing performance in service organizations, *Sloan Management Review*, 54 (4), pp.37-42.

Siddiqui, A.A., Mirani, Z.A. and Bukhari, S.S. 2012 Impact of Farmer Field School Training on Farmers' Knowledge and Skills regarding Recommended Agro-Ecological Sound IPM Practices in Selected Districts of Sindh. Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Sciences, 28, pp. 186-198.

Sibiko and Kenneth, W. 2012. Determinants of Common Bean Productivity and Efficiency: a case study of smallholder farmers in eastern Uganda. PhD diss., Egerton University.

Srinivas, T., Rizvi, S. J. H., Hassan, A. A., Manan, A. R., & Kadian, M. S. 2012. Technical efficiency of seed potato farmers of Badakshan Province of Afghanistan.

Timmer, C. Peter, 1971. Using a probabilistic frontier production function to measure technical efficiency. *Journal of Political Economy* 79, pp. 776-794.

Tingley, D., Pascoe, S., & Mardle, S. 2003. Estimating capacity utilisation in multi-purpose, multi-metier fisheries. *Fisheries Research*, *63*(1), pp. 121-134

Tripp, R., Wijeratne, M., & Piyadasa, V. H. 2005. What should we expect from farmer field schools? A Sri Lanka case study. *World Development*, 33(10), pp.1705-1720.

Vestergaard, N., Squires, D., & Kirkley, J. 2003. Measuring capacity and capacity utilization in fisheries: the case of the Danish Gill-net fleet. *Fisheries Research*, *60*(2), pp. 357-368.

Yorobe, J. M., R. M. Rejesus, and M. D. Hammig. 2011. Insecticide use impacts of integrated pest management (IPM) farmer field schools: Evidence from onion farmers in the Philippines." *Agricultural systems* 104(7), pp. 580-587.

Appendix

Questionnaire

Impact of Farmer Field School on Efficiencies of Tobacco Growers: A Case study of District Swabi

S.No______________ Name of village____________

I. General information about the respondents:

1. Name ________________________
2. Age ________________
3. Education in year's _________________

II. Total Household size ____________________

III. How many Household members' works in Tobacco field_____________________

IV. Total experience in farming (year's)

____

V. Occupation of Farmer if any other

VI. Income of Farmer

a) Monthly

b) Yearly

VII. Tenurial status:

a. Owner

b. Owner cum tenants

c. Tenants

VIII. Acres of land on which tobacco is grown:

a. 1-5 acres

b. 5-10 acres

c. 10-15 acres

d. 15-20 acres

e. Or above.

XI. Irrigation source:

a. Canal
b. Tube well
c. Barany
d. Other specify

X. Do you face the irrigation problems?

a. Yes Or No

If yes then specify:

b. Water is not sufficient for the irrigation of tobacco

c. Water supply schemes are not good

d. Water is not sufficient in the canals, during the proper season of tobacco

XI. Number of Extension visit___________________

XII. What type of agricultural techniques you are using in tobacco cultivation?

a. Traditional method

b. Modern method

c. both methods

XIII. If you are using modern techniques then specify the difficulties?

a. Expensive

b. Cannot do all work

c. Any other

XIV. Cost of tobacco production per acre:

Production Cost	Details of inputs/operation	Tobacco	
		Quantity	Cost (Rs)
Land Preparation	Seed (gms/acre)		
	Deep ploughing		
	Planking		
	Leveling		
	Total Tractor Hrs		
	Bullock (Hrs)		
	Total Bullock HRs		
Labor (Days)	Land preparation		
	FYM application		
	Fertilizer application		
	Pesticides application		
	Irrigation		
	Harvesting		
	Post harvesting		
	Threshing		
	Total Labor Hrs		
Fertilizer Application	Urea (Kg/acre) DAP (Kg/acre) FYM (Kg/acre) Other (Specify)		
Pesticides	Liters/Kg/acre Number of time sprayed Brand		
Irrigation	Number of irrigation		
Total Production Cost (TPC)			
Marketing Cost	Packing materials/Bags		
	Loading		

	Transportation		
	Unloading		
	Market fee		
	Measurement charges		
	Commission charges		
	Other (specify)		
Total Marketing Cost (TMC)			

XV. Do you face problems in plucking and picking the tobacco leaves?

Yes Or No

If yes then specify the problems:

a. Shortage of skilled labor

b. High daily wage

c. Difficult in doing themselves

XVI. Do you face leaves grading problem?

a. Yes

b. No

XVII. What is your current tobacco output?

XVIII. Are you satisfied with the present tobacco production?

a. Yes

b. No

If no then specify:

a. Inappropriate seed

b. Irrigation system is not good

c. Use inappropriate fertilizer

d. Due to weather and soil condition

XIX. Are you satisfied with the cooperation of financial institution ZTBL or PTC?

a. Yes

b. No

If no then specify:

a. High rate of interest

b. Process of getting loan is complicated

c. Loan is issued to approachable person

XX. Are you registered in Farmer Field School?

Yes or No

If yes why, if no why?

XXI. Which of the following things you received from FFS?

a) Higrometer, Standard spraypump, Plupipes and Protective Productive equipments
b) Fertilizer and pesticide
c) Training
d) Both a and b
e) Any other