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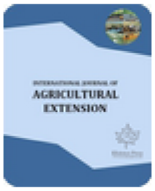

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IMPACT ASSESSMENT OF PLANT CLINICS ON FARM INCOME OF FARMERS IN THE PUNJAB, PAKISTAN

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ABSTRACT

Plant clinics are a novel channel of providing low-cost and regular plant health services to farmers in developing countries. Limited research has been conducted on the assessment of plant clinics in Pakistan. The plant clinics are playing an effective role in agricultural development through the dissemination of technical guidance to the farmers. This study was conducted in the Punjab province of Pakistan to assess the impact of plant clinics on the income of farmers. A total of 353 randomly selected farmers were interviewed from the two districts of Punjab province, Gujranwala and Multan through a face-to-face interview technique. Collected data were analyzed through the Statistical Package for Social Sciences (SPSS). Along with the descriptive analysis, the Ordinal Logistics Regression (OLR) model was applied to estimate the impact of plant clinics on the income of the farmers. Findings indicated that advisory services served by plant doctors were useful for the farmers. Plant protection relate services were more useful as compared to the agronomic attributes of the crops. Perhaps, the services rendered helped farmers to curtail their cost of production. Later, the OLR analysis confirmed an increase in income of those farmers who perceived the usefulness of providing advisory services to a high level. This study urged plant doctors to pay more attention to the agronomic attributes of the crops.

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INTRODUCTION

The world's population may reach 9 billion by 2050. To fulfill the food requirements onus remains on the agriculture sector and the farming community is the major stakeholder in this context. Around two-thirds of the total poor people in the world live in rural areas and most of them had over-reliance on agriculture sector for their livelihoods (Mogues *et al.*, 2009). Agriculture is augmented as a growth engine for sustainable development in deprived areas in particular. However, the sector is often constrained by the lack of access to appropriate technologies and site-specific and improved techniques, institutional inefficiencies, and poorly dealt with problems of management of agriculture education, research orientation and advisory mechanisms. Consequently, the farming communities are compelled to practice farming under limited resources and face sluggish use of knowledge, skills, and innovations (Asenso-Okyere *et al.*, 2008). To alleviate the obstacles and expedite the growth particularly in underprivileged rural areas agriculture advisory services have been integrated into the global development agenda (Birner *et al.*, 2009).

All over the world pests, weeds and diseases cause 26-40% losses of prospective yield until the harvesting of major crops. Farmers often use pesticides to overcome these losses but increasing use of pesticides is contaminating these crops with mycotoxins and ultimately making it impure and unhygienic food for animals and human beings (European Commission, 2005). In this context, almost every country in this world has a systematic advisory service system for the farmers (Zhang *et al.*, 2017). Facilitating and providing technical backstopping services to the farmers' remains the core function of advisory service providers. Educating farmers to bring positive changes in their knowledge, attitude and, skills is regarded as the philosophy of advisory service. Once the farmers have felt improvement in their knowledge about agriculture, attitude and skills, he easily turns to be the innovator of agricultural innovations adoption. The adoption of innovations further leads him to harvest potential production and premium returns (Wordofa and Sassi, 2017).

Being a fifth most populace nation in the world, in Pakistan, the agriculture sector is the lifeline for national GDP with 19.9% GDP share and livelihood support directly to 42.3% of population. Population in the country is growing 2.04% annually, asking for more food to feed such a gigantic population (United Nations, 2019). It can be stated, the agriculture sector is the discourse to be focused by the stakeholders forthwith to produce required food. In Pakistan, a separate wing of the department of agriculture extension is working since 1962 for the facilitation of farmers and meet the information needs of farmers. Apart from that, the extension wing is mainly responsible to educate farmers informally for their technical uplift (District Government Muzaffargarh, 2004; Lodhi *et al.*, 2006). Extension in Pakistan is aimed at bridging the knowledge and information gap of farmers (Hassan, 2012).

However, studies such as Talib *et al.* (2017), Rahim *et al.* (2003), Ali *et al.* (2009), Abbas *et al.* (2009), Farooq *et al.* (2010) and, Khan *et al.* (2012) had concluded that extension staff was unable to meet the farmers needs for the many reasons. To facilitate farmers, various experiments have been conducted to make extension system efficient. In 2012 an experiment named as Plant Clinic was established in the Punjab, province of Pakistan. CABI cashed this idea whereas Agriculture Extension wing of Punjab Agriculture Department province joined hands for the successful establishment of plant clinic across Punjab (Plantwise Data Management Report, 2014).

Plant Clinics, aimed at providing farmers with technical advice on problems regarding plant health (Boa *et al.*, 2016). In this technique, farmers visit the plant clinic, staged by trained extension agents' terms as plant doctors on a prominent place of the area to seed the technical guidance. Coming to history, Bolivia was the pioneer country to start a plant clinic in 2000. Plant clinic doctors' course was started by CABI in 2005 (Boa, 2009).

Plant clinic users demonstrated increased yields and incomes of farmers in different countries. For instances, plant clinics in Malawi enhanced the awareness and knowledge of tomato pests and diseases, which improved the adoption of interventions and tomato yields in Malawi (Plantwise, 2018) while in Bolivia farmers were improving their income by acting on the clinics' prescriptions. Poor and small farmers were enjoying the maximum increase in income (Bentley et al., 2011). The income of small-scale growers influence significantly and positively by the plant protection costs (Adil *et al.*, 2004).

The results of the impact assessment study on the impact of plant clinics in Uganda (Brubaker *et al.*, 2013) were less optimistic than results which are found for other plant health clinic programs in Bangladesh and Bolivia (Harun-Ar-Rashid and Boa, 2010; Bentley *et al.*, 2011). It was argued that plant clinics take a long time to increase yield and income (Brubaker *et al.*, 2013). Despite the successful journey of plant clinics in Punjab, Pakistan, there is a research gap on the effectiveness and prospects of the plant clinics in Pakistan. Plant clinics are never brought under investigation by researchers in Pakistan. Therefore, a gap in the literature exists regarding impact assessment of plant clinics in Pakistan and there is need to bridge this gap. This study is an attempt to present a shred of empirical evidence on the impacts of plants clinics are having on the farm income of the farmers. The major objective of the study was the impact assessment of plant clinics on farm income of farmers. The main objective was further divided into the investigation of demographic attributes of the respondents and estimation of the usefulness of advice served to the farmers as perceived by the plant clinic users.

METHODOLOGY

A cross-sectional survey research design was employed in this study. When two or more variables are likely to correlate, the cross-sectional research design is regarded as most suitable to determine the results (Chaudary *et al.*, 2016). Punjab, the largest province in terms of the agriculture sector was the study area. The Punjab province is the pioneer as the first plant clinic of Pakistan with a joint venture of CABI and agricultural extension wing was initiated in the district Gujranwala and Bahawalpur in 2012. Till now, 906 plant clinics have been established in Pakistan where 1782 plant doctors are serving farmers (Plantwise, 2018).

This study was further downsized to two districts Gujranwala and Multan, selected through simple random sampling technique. From these districts, tehsil Multan Saddar and Jalalpur Pir Wala from Multan and tehsil Gujranwala Saddar and Wazirabad were selected randomly from district Gujranwala. In district Gujranwala and Multan, total of 15 and 46 plant clinics are established where 15 and 30 plant doctors are working, respectively. Both districts had distinct significance in terms of agricultural production in the province. District Gujranwala is known for its momentous production under rice-wheat cropping pattern (Talib *et al.*, 2017) whereas Multan is globally renowned for mango quality and tremendous potential of cotton. Almost 80% of the population in Multan is dependent on agriculture for their livelihoods. The upsurge in agriculture accentuates the stunning potential of plant clinics in selected areas.

Selection of sample was a key stage of the methodology and to develop a sampling frame a detailed list of plant clinic users was requested from the office of Director of General (Agriculture Extension & Adaptive Research), Punjab. The list comprises of 8936 plant clinic users. The critical evaluation of the list identified 4390 plant clinic users in the selected sub-districts. The criteria for the selection of respondents were that the farmers must have been sourcing agricultural advice from plant clinics for the last 2 years. Hence, 4390 farmers existing in the list served as the targeted population for the study. The online website www.surveysystem.com was used for the computation of sample size at 95% confidence level and 5% confidence interval. Consequently, 353 respondents were selected at random as respondents for the study.

The interview schedule was used as a data collection instrument. The interview schedule was prepared in the line of the objectives and pre-tested on 20 plant clinic users in the district Faisalabad. These 20 respondents were other than the total sample size of the study. The interview schedule had questions regarding demographic attributes of the respondents and the usefulness of the technical advice received by the farmers regarding agronomic and plant protection related attributes. Data were collected through face-to-face interview technique.

Collected data were analyzed using Statistical Package for social sciences (SPSS). Descriptive as well as inferential statistics were applied to data. To compute the usefulness of technical advice, mean and the standard deviation were calculated. Whereas, to examine the impact of plant clinics services on the income of the farmers was tested empirically by the OLS-Ordinary Logistics Regression Model. The income of the farmers was dependent variables whereas the agronomic and plant protection related aspects were kept as explanatory variables. The description of the variables is given in Table 1.

Table 1. Definition of variables.

Variables	Definition
Dependent variable	
Income	1=high, 2=medium, 3=low.
Explanatory variables	
Weed management (x_1)	1=high, 2=medium, 3=low, 4=no
Seed treatment (x_2)	1=high, 2=medium, 3=low, 4=no
Fertilizer application (x_3)	1=high, 2=medium, 3=low, 4=no
Seed bed preparation (x_4)	1=high, 2=medium, 3=low, 4=no
Seed rate and spacing (x_5)	1=high, 2=medium, 3=low, 4=no
Proper irrigation (x_6)	1=high, 2=medium, 3=low, 4=no
Sowing time information (x_7)	1=high, 2=medium, 3=low, 4=no
Soil analysis (x_8)	1=high, 2=medium, 3=low, 4=no
Safe use of pesticides (x_9)	1=high, 2=medium, 3=low, 4=no
IPM for insect and disease control (x_{10})	1=high, 2=medium, 3=low, 4=no

Identification of beneficial insects (x_{11})	1=high, 2=medium, 3=low, 4=no
Identification of insect/pest and diseases (x_{12})	1=high, 2=medium, 3=low, 4=no
Identification of harmful insects (x_{13})	1=high, 2=medium, 3=low, 4=no
Post-harvest handling (x_{14})	1=high, 2=medium, 3=low, 4=no
Pesticides for insect and disease control (x_{15})	1=high, 2=medium, 3=low, 4=no
Diseased or insect samples send to lab (x_{16})	1=high, 2=medium, 3=low, 4=no

The description of the OLR model applied is given as under;

OL regression is applied to the data that meet the proportional odds assumption. Whereas, the uses of OL regression include ordering the categorical response variables. The OL regression model fits multiple logistic regression on a multi-category ordered variable that has been dummy coded. The response variable is categorical response variable with categories: $Y \in (0,1, \ldots\ldots K)$

$$Y = \begin{cases} 0, No \\ 1, \quad high \\ 2, \quad Medium \\ 4, \quad Low \end{cases}$$

The proportional odds supposition conditions that the number added to each of the set logarithms to obtain the next is the same in every case to set an arithmetic sequence, the reference category is 3=reference group and so non-reference categories have a linear regression function with the regression parameters given as;

$\beta_j = (\beta_{1j}, \beta_{2j} \ldots\ldots\ldots\ldots\ldots\ldots \beta_{pj})$ where $J = 0,1, \ldots\ldots\ldots$ K

And a set of predictor variable vector with p predictor variables

$\acute{X\iota} = (X_{ip}, X_{2p} \ldots\ldots\ldots\ldots\ldots X_{ip})$ where $i = 1,2,3, \ldots\ldots\ldots\ldots, n$

The link function is an alteration of the likelihoods that permits for model estimation, in OL regression, the logit is link function; the link as mentioned described what drives to the left side of the equation connecting the random component on the left and the systematic component on the right side of the equation (Adejumo and Adetunji, 2013). The logit equations of the OL regression model assess the log odds of each of the non-reference response variables to the categorical variable of random choice, logit equations is as follows;

$log = \left[\frac{\pi_1+\pi_2+\pi_3}{\pi_{j+1}+\pi_{j+2}+\cdots+\pi_j}\right] = log\left(\frac{P(Y=j/X_i}{P(Y=0/X_i}\right) = \acute{X}_i\beta$ ……………………………… (Eq. 1)

The response likelihood is then determined exclusively. Thus, the summation is equal to one;

$P\left(Y = \frac{0}{X_i}\right), P\left(Y = \frac{1}{X_i}\right), \ldots\ldots\ldots\ldots P(Y = \frac{j}{X_i})$

Where j=0, 1,2,3 and where i=1,2, 3,………,n

$$\sum_{j=1}^{k} P(Y = \frac{j}{X_i}) = 1$$

$\boldsymbol{\pi_{ij}} = \frac{\sum_e^j k=1x_i\beta_k}{1+\sum_e^j k=1x_i\beta_k}$…………………… (Eq. 2)

$\boldsymbol{\pi_{ij}} = \frac{1}{1+\sum_e^j k=1x_i\beta_k}$……………… (Eq. 3)

For a polytomous outcome, and predictors, the systematic part of the model is defined as follows:

This can be re-expressed in terms of the individual category outcome probability by solving

for the unique likelihoods to give:

$$Log\left[\frac{P(x_1, x_2, x_3 \ldots\ldots\ldots x_p}{1 + P(x_1, x_2, x_3 \ldots\ldots x_p}\right] = \beta_{0j} + \beta_{ij}X_{1j} + \beta_{2j}X_{2j} + \cdots + \beta_{pj}X_{pj} \ldots\ldots\ldots\ldots\ldots \text{(Eq. 4)}$$

$$P(x_1, x_2, x_3, \ldots\ldots\ldots x_p) = \frac{e(\beta_{0j} + \beta_{1j}X_{1j} + \beta_{2j}X_{2j} + \cdots + \beta_{pj}X_{pj})}{1 + e\,(\beta_{0j} + \beta_{1j}X_{1j} + \beta_{2j}X_{2j} + \cdots + \beta_{pj}X_{pj})} \ldots\ldots \text{Eq. 5)}$$

For a given predictor x_i, the coefficient β_i gives the change in log odds of the outcome associated with a unit increase in x_i, for arbitrary fixed values for the remaining predictors $x_1, x_2, x_3, \ldots\ldots\ldots x_p$. The exponentiated regression coefficient exp (β_i) represents the odds ratio associated with a one-unit change in x_i ' (O'Connell, 2006). Logistic slope coefficients are described as the effect of a unit of change in the X variable on the predicted logit with the other variables in the model held constant. That is, how a one-unit change in X affects the log of the odds when the other variables in the model are held constant.

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RESULTS AND DISCUSSION

This section is the description of results on set objectives like demographic attributes of the respondents, usefulness of the information and, advisory services obtained from the plant doctors by the farmers who were active users of plant clinics. This section also had a description of the empirical model, OL regression to identify the impact of advisory services received by the plant clinic users on their farm income.

Table 2. Demographic attributes of the respondents.

Demographic attributes	Mean ± SD
Age (years)	44.74 ± 12.0
Education (years)	5.736 ± 5.070
Size of landholding (acres)	10.38 ± 8.671
Farming experience (years)	21.64 ± 15.23
Distance from plant clinic (Kilometres)	6.62 ± 4.68
Tenancy status (%)	
Owners	66.3
Tenants	12.2
Owner-cum-tenants	21.5
Members of plant clinic	
From 4 years or less	56.4
From 5-6	32.6
From more than 6 years	11

Demographic attributes of the respondents

The demographic attributes of the respondents include age, years of schooling, size of landholding, experience in farming and genders of the respondents. For this study, age, education, land size, distance from plant clinics, tenancy status and duration of being a member of plant clinics were the factors included in the demographic section.

Table 2 shows that the mean age of sampled plant clinics users was 44.74 years. Farmers had an average schooling of 5.7 years. Average landholding size appeared 10.38 acres whereas sampled farmers had a farming experience of 21.64 years on average. Of the total respondents, 66.3% were owners of their lands followed by the tenants (12.2%) and Owner-cum-tenants (21.5%). This can be deducted from the findings that farmers had considerably productive age but the ordinary level of education. Farmers seemed highly associated with the farming as land size upheld by them was a considerably large and tremendous experience of farming was reported. This is the notion that being frequent in farming, the farmers would be urging more advice on different ventures of farming. On average 6.62 kilometers, travelled by the farmers to access technical guidance from the plant doctors endorse the importance of farming for the farmers and their livelihoods. More than half of farmers (56.4%) were the frequent users of plant clinics for approximately 4 years. About 33% of farmers had an association with plant clinics from 5-6 years followed by the 11% farmers who were visiting plant doctors for more than 6 years. These findings further accentuate the trust among farmers that plant doctors have developed through the effectively extended services.

Usefulness of plant clinics' services received by the farmers

Farmers were accessing technical advisory services from the plant doctors on multiple avenues regarded necessary for the potential outcomes. Among various aspects, agronomic and plant protection related contents were followed and accessed more. Plant clinics are knowledge source where farmers often come to get their problems solved. The problems being faced could be of diverse range like insects, pests, and diseases identification. Whereas, the plant doctors act as a facilitator to visiting farmers and had the motive to improve farmers' livelihoods through scientific diagnosis and technical backstopping (Bentley *et al.*, 2011). Plant doctors recommend agronomic and plant protection related strategies to farmers which can curtail the cost of production and multiply the net returns (Talib *et al.*, 2017; Srivastava, 2013). Farmers approached plant clinics and received advisory services on different aspects of farming. The respondents were asked to explore the usefulness of different services as received by them from the plant doctors (Table 3). Usefulness was recorded on a five-point Likert scale where 1=Never 2= Rarely 3= Sometimes 4= Often and 5= Always. This implies that mean value ascending to high will explain the level of effectiveness. With the increase in mean values, the usefulness will be regarded as higher.

Table 3 shows, advisory service about proper irrigation techniques was perceived highly useful by the farmers (X=4.11). Farmers of the study area brought emerging issues like water scarcity and cost-effective methods of irrigation with the plant doctors. Farmers being visionary in water security and judicious use of irrigation points to the effectiveness of productive discussion held between plant doctors and farmers. Balanced application of fertilizers to improve the production of crops by sustaining the soil health was the aspect found useful by the sampled farmers (X=4.03). Weeds, being competitive the crop for fetching food harness negative impacts on the plant health and production eventually. Plant doctors guided the visitors in their best interest and farmers perceived advisory services useful of closely high level (X=3.99). Findings summarize that respondent had more inclination towards the advisory services related to agronomic practices. In a previous study, Hussain *et al.* (2012)had reported that 96% of farmers accessed guidance about the cultural and agronomic aspects of farming. Adhikari *et al.* (2013) had concluded that the majority of the recommendations made by the plant doctors in Nepal were related to agronomic and cultural aspects of farming.

The results indicate that the sampled farmers sought technical guidance regarding seed treatment (X=3.97) and seedbed preparation (X=3.89) and usefulness of served guidance stood between medium and high level. Adoption of recommended techniques of seed treatment and seedbed preparation by maintaining plant to plant and row to row distance not only curb the production cost but also ease the infestation of insects, pests, and fungal diseases. Following the recommended seedbeds and seed rate accelerate the plat growth and harness the best yield. Therefore, technical advice on sowing time of the different crops was perceived useful of medium to a high level (X=3.70). Technical service regarding soil analysis embarked the least usefulness among farmers (X=3.34). The soil is a natural resource and its obligatory use soil according to its nature and capacity to expedite productivity. The limited usefulness of disseminated advisory indicates more attention needs to be paid by the plant doctors in wake of sustainable soil health.

Farmers are advised about the cultural, chemical (pesticides) and biological control and, Integrated Pest Management technique to yield desired control to the menace. Post-harvest handling of the produce was vastly approached concern of the farmers and it was rated highly useful (X=4.20) to keep their produce safe from post-harvest damages. Post-harvest handling encompasses the blend of different techniques including pesticide application. Plant doctors advised the farmers about the safe application of pesticides and the service was perceived highly useful (X=4.19). Ghiasi *et al.* (2017) categorized plant clinics usefulness in Iran into poor, fair, good and excellent and found that (X=3.92) for the usefulness of plant clinics services. Moreover, there was a close link between education and usefulness of plant protection practices. They suggested that plant clinics need widespread advertisement in accordance with their fields of activity, so that they can turn themselves into well-known institutions in the targeted society. Beneficial insects and pests are the source of biological control, but on poor knowledge, the farmers usually kill them while spraying on the crops. Farmers were found learning about the identification of beneficial insects and pests (X=4.12) followed by the identification of insects, pests and disease attacks on the crops (X=4.11). The advisory received was perceived useful to more than high level.

Recommendations about the IPM to control insects, pests and diseases attack were regarded highly useful (X=4.07) followed by the chemical control of insects and diseases (X=4.00). This information was much lucrative for the farmers. Because the infestation of insects and diseases cause huge damage to the growth and development of the crop. Taking the potential damage due to insects and disease into the account, the farmers obtained information from plant doctors about the harmful insects and their identification (X=3.90). Sometimes, farmers were found accessing information regarding the delivery of diseased or insects attacked samples to forward to the lab for further analysis and devising a concrete solution. Findings are supported with those of Negussie *et al.* (2011) where they found that farmers were using improper pesticides and plant doctors advised them to stop using these improper sprays. In this essence plant clinics are thought to be curtailing the cost of farmers (Bentley *et al.*, 2011).

Table 3. The usefulness of technical advice received by farmers.

Advisory services related to.	Mean ± SD
Agronomic practices	
Weed management	3.99±.96
Seed treatment	3.97±.96
Fertilizer application	4.03±0.91
Seedbed preparation training	3.89±1.25
Seed rate and spacing	3.83±.88
Proper irrigation	4.11±1.02
Sowing time plant information	3.70±.90
Soil analysis	3.34±1.12
Plant Protection services	
Information related to the safe use of pesticides (Application Techniques)	4.19±.88
Recommend IPM for insect and disease control	4.07±.89
Identification of beneficial insects	4.12±1.06
Identification of insect/pest and diseases problems	4.11±0.91
Identification of harmful insects	3.90±0.79
Advisory services related to post-harvest handling	4.20±0.95
Recommend chemical pesticides for insect and disease control	4.00±.99
Diseased or insect samples send to the lab	3.52±1.26

Impact of pant clinics on Income

This section is about the association of technical guidance served at plant clinics with the farmers' income. It was anticipated that the income level of farmers would have risen with the operation of plant clinics. This hypothesis was tested empirically (Table 4). Findings shows, number of the explanatory variables were significantly associated with an increase in income. The usefulness of information regarding soil analysis had a significant impact on the rise in income of the farmers ($P<0.05$). For the sampled farmers who perceived advisory as effective to a medium and high level, they had significantly increased their income to 6.3 and 7.2% respectively. Those farmers, who perceived the guidance useful to low level didn't have any impact on their income. This indicates, with the increase in the usefulness of advice the probability of an increase in income increased significantly. In the case of the low level of usefulness, farmers for many reasons were not able to surge their income level. Possibly, various reasons could be behind the poor use of advice such as an inadequate level of education, small landholdings and old age of the farmers in particular. Personal attributes of the respondents explained 71.99% of the variation in farmers information-seeking knowledge (Dinpanah and Lashgarara, 2011). Personal characteristics of the farmers like age, education, the land size was significantly associated with the knowledge and awareness about the recommended production practices (Ashraf *et al.*, 2015). Siddiqui *et al.* (2006) had concluded that with the unit increase in age of farmers the interest to access new information decreases over time. Acheampong *et al.* (2017) urged that to effectively utilize the information by farmers regarding the application of fertilizer, disease control, weeds control and proper irrigation, it will need careful investment in improving the technical abilities such as education of the farmers.

Recipients of advisory services about sowing time of crops witnessed an increase of 0.8% and 1.1% increase in their income ($P<0.05$). As a result of the guidance, farmers cultivated their crops timely which led them to harvest potential yield. High yield is directly associated with the time and properly adopted sowing techniques. Delayed sowing curtails the production and surges the cost of production. Delayed sowing shortens the vegetative growth of crops and lessens the yield (Akmal *et al.*, 2000). Hussain *et al.* (2012) found 60kg ha^{-1}

reduction in wheat yield planted post 10th November in Pakistan. Recommended sowing techniques help in seed placement and foster seed germination to give potential results (Asoodar and Yousefi, 2013). Farooq *et al.* (2015) concluded that wheat cultivated at 15th of November resulted in high production and a high amount of starch and protein contents in the grains. Considering the technique of sowing vital, respondents had great consideration of seeking technical advice regarding seedbed preparation.

The sampled farmers who found technical advice about seedbed preparation medium to highly useful, roused their income ($P<0.05$). Application of fertilizers, irrigation and control over weeds had contribution too in high yield of crops. Those farmers, whom the technical advice regarding fertilizer and irrigation were highly useful, observed an increase in their income ($P<0.05$). Whereas those respondents who found the information useful but of low to medium level, they didn't felt the impact on their farm income. Perhaps, they were not able to adopt the recommended doses of fertilizers and irrigation application techniques. In this regard, farmers should be convinced to adopt recommendations. Inadequate and improper use of fertilizers and irrigation not only reduces the production but also bring stress to the soil and later can expedite the emergence of soil borne diseases and problems. Improper use of fertilizer and irrigation foster the germination of weeds which are regarded as the major competitor of the crops for nutrients absorption. It is well reported that weeds infestation can decrease the production of crops differently. In a previous study Safdar et al. (2019) found 10-28% reduction in wheat yield due to weeds infestation. Whereas, it was reported 25.3% in India by Gharde *et al.* (2018). According to Karim (1998), the potential loss of production of food crops due to weeds can reach 33.16%, 41.26% in cereals and 40.28% in rice crop. From the plant clinics, the majority of the farmers sought advice to alleviate weeds and found it often useful ($X=3.99$). Farmers who had perceived advisory a useful from medium to high level viewed the substantial rise of income. Effective weed management had a significant influence on the grain yield of rice (Alam *et al.*, 2002). This incurs a resultant increase in profitability in the wake of effective management of weeds.

Apart from agronomic practices, plant protection measures had a role in farm income rise. Otherwise, the prevalence of the insects, pests, and diseases can potentially cause unprecedented loss to production. Karim (1998) had projected 1383-million-dollar loss in Bangladesh due to insects' pest infestation. Oerke (2005) has identified the potential loss of insects' pests in the world differently. For the wheat, the potential loss was recorded 50% and 80% for cotton followed by 26-29% soybean. Advisory services related to plant protection helped farmers to identify insects, pests, and diseases and differentiate between the beneficial and harmful insects. Though, identification of insects, pests, and diseases appeared non-significant with the rise in income ($P>0.05$). But, the importance of being known to insects' pests cannot be ignored. This awareness triggered the control of insects, pests, and diseases. Plant doctors recommended different insecticides and pesticides to the farmers to control insects' pests and diseases but it doesn't show a significant relationship with the income. Rather than bringing a to income, it escalated the cost of production, developed resistance in the insects and pests and lowered the quality of produce. IPM was regarded as a feasible and effective technique to control insects, pests and diseases and obtain a high yield of crops (Alam *et al.*, 2016). The IPM adopting farmers, irrespective to the perceived usefulness of the technical advice, viewed a significant rise to their income ($P<0.05$). For the farmers, who considered IPM recommendations useful of the low, medium and high level observed 0.3,0.7 and 1.3% rise in their income. Curtailing the cost of production through IPM was the major reason to stand productive for the farmers. IPM user farmers were way ahead in controlling costs and improving their profit levels as compared to non-IPM users (Sanglestsawai *et al.*, 2015).

Effective control of insects' pests, conservation of ecosystem, and durable control were the additional reasons for establishing a significant association with the rise in income. Alongside IPM recommendations, advisory service regarding post-harvest management of produce appeared significant with the rise in income ($P<0.05$).

Farmers obtained advisory services regarding post-harvest handling and found it highly useful ($X=4.20$). The farmers who perceived it medium to a high level useful were likely to increase their income by 0.5 and 1.8% respectively. Whereas the farmers assuming it lesser useful than those who didn't receive any positive impact on their income. If post-harvest management is not adopted in good order, it can cause a severe economic loss. Sawicka (2020) overviewed that one-third of the total food produced in the world is wasted due to poor post-harvest management. The amount of wasted food is equivalent to greater than half of the global annual crop production (almost 2.3 billion tons/year). To increase profitability and availability of the food effective post-harvest management strategies are important to be adopted on the farm level.

Table 4. Impact of plant clinic on the income of plan clinic users.

Variables	Variables	Estimates	Standard error	Wald	***P***
Income	[Y = 1.00]	-5.186	.745	48.424	.000
	[Y = 2.00]	-1.965	.695	7.985	.005
Soil analysis	[x1=1.00] high	.456	.621	.539	.063*
	[x1=2.00] medium	-.800	.444	3.242	.072*
	[x1=3.00] low	.015	.518	.001	.977
	[x1=4.00] no	0[a]	.	.	.
Sowing time	[x2=1.00]	1.685	.636	7.018	.008
	[x2=2.00]	.518	.525	.975	0.011
	[x2=3.00]	-6.680	1.836	13.236	.324
	[x2=4.00]	0[a]	.	.	.
Seed bed preparation training	[x3=1.00]	1.411	.829	2.900	.089
	[x3=2.00]	2.298	.949	5.866	.015
	[x3=3.00]	.528	1.806	.085	.770
	[x3=4.00]	0[a]	.	.	.
Seed rate and spacing	[x4=1.00]	-.352	1.501	.055	.814
	[x4=2.00]	.662	1.473	.202	.653
	[x4=3.00]	0[a]	.	.	.
	[x4=4.00]	0[a]	.	.	.
Advisory services for seed treatment	[x5=1.00]	.631	1.373	.211	.646
	[x5=2.00]	.573	1.347	.181	.671
	[x5=3.00]	2.154	1.309	2.708	.100
	[x5=4.00]	0[a]	.	.	.
Advisory services related to fertilizer application	[x6=1.00]	.012	1.353	.000	.000
	[x6=2.00]	.429	1.327	.104	.747
	[x6=3.00]	19.252	1.564	151.517	.993
	[x6=4.00]	0[a]	.	.	.
Proper irrigation	[x7=1.00]	-1.420	.710	3.998	.046
	[x7=2.00]	-.593	.780	.578	.447
	[x7=3.00]	-16.347	.000	.	.
	[x7=4.00]	0[a]	.	.	.
Weed management	[x8=1.00]	-3.049	.776	15.432	.000
	[x8=2.00]	-1.624	.754	4.636	.031
	[x8=3.00]	0[a]	.	.	.
	[x8=4.00]	0[a]	.	.	.
Identification of beneficial insects	[x9=1.00]	-5.738	1.376	17.376	.000
	[x9=2.00]	-3.417	1.207	8.012	.005
	[x9=3.00]	-4.607	2.038	5.110	.024
	[x9=4.00]	0[a]	.	.	.
Identification of harmful insects	[x10=1.00]	-3.283	1.109	8.762	.003
	[x10=2.00]	-1.654	.930	3.165	.075
	[x10=3.00]	11.334	2372.447	.000	.996
	[x10=4.00]	0[a]	.	.	.
Identification of insect/pest and	[x11=1.00]	.656	.761	.744	.388

diseases problems					
	[x11=2.00]	.713	.684	1.087	.297
	[x11=4.00]	0[a]	.	.	.
Disease or insect samples send to lab	[x12=1.00]	-1.805	.571	9.999	.102
	[x12=2.00]	.886	.538	2.712	.100
	[x12=3.00]	2.128	1.750	1.480	.224
	[x12=4.00]	0[a]	.	.	.
Recommend insecticides and pesticides for insects and disease control	[x13=1.00]	1.429	1.011	1.998	.157
	[x13=2.00]	1.165	.973	1.435	.231
	[x13=3.00]	-1.739	2.255	.595	.441
	[x13=4.00]	0[a]	.	.	.
Recommend IPM for insect and disease control	[x14=1.00]	4.527	1.527	8.796	.003
	[x14=2.00]	3.891	1.452	7.177	.007
	[x14=3.00]	8.923	3.589	6.182	.013
	[x14=4.00]	0[a]	.	.	.
Provide advisory services related to post harvest handling	[x15=1.00]	-3.071	1.083	8.043	.005
	[x15=2.00]	-2.844	1.200	5.621	.018
	[x15=4.00]	0[a]	.	.	.
Information related to safe use of pesticides (Application Techniques)	[x16=1.00]	.511	.993	.265	.607
	[x16=2.00]	-.021	.994	.000	.983
	[x16=3.00]	0[a]	.	.	.
	[x16=4.00]	0[a]	.	.	.
N= 353, R squared=0.534, McFadden=.357, LR chi^2=58.03					

CONCLUSION AND RECOMMEDNATIONS

This study concludes that most of the sampled farmers were in their productive ages but their level of education was below average. Farmers were highly associated with the farming as land size upheld by them was considerably large and farmers were coupled with tremendous experience of farming. Being frequent in farming does mean farming means a lot to the farmers. To upsurge their farm income farmers would be in a great deal to access technical guidance on various aspects of farming. Farmers were travelling a larger distance to contact the plant doctors for technical guidance. This endorses the vitality of farming for the farmers and the passion of farmers to learn diversified aspects of the farming. Farmers appeared deemed to increase their farm income. Thus, the emergence of plant health clinics bridged the gap held between extension advisory services. Plant health clinic services were perceived effective by the users on different aspects of the farming which paved the ways for escalation farm income eventually. Technical guidance served on topics such as irrigation techniques and fertilizer application were perceived highly useful. Whereas, the guidance over weed management, seed treatment, seedbed preparation, seed rate, sowing time, and soil analysis appeared ranging between medium and high level. Among, plant protection services, post-harvest handling, safe use of the application, identification of beneficial insects, identification of insects, pests and diseases, IPM and chemical control-related advisory services appeared highly effective. Whereas, identification of harmful insects and sending the diseased sample to a lab for the analysis related guidance was perceived effective of medium level. Comparison affirms that information floated regarding plant protection measures were more useful than the guidance over agronomic practices.

Regarding the impact of the usefulness of plant clinic services on the income of the farmers, empirical findings confirmed a positive role in the increase in income. Most of the variables were significant in increasing the income of farmers. For those farmers who had perceived technical guidance useful of high level, particularly viewed an increase in their income. This indicates, with the unit increase in the usefulness of advice, the possibility of an increase in income of farmer exists.

This study finally concludes with the importance of plant clinics for the farmer and an increase in farm income. However, this study also urges further improvements to, improve the potential benefits. Plant doctors should pay more attention to the agronomic attributes of farming to improve the knowledge of farmers. Similarly, farmers should be guided to decrease the chemical control of insects, pests, and diseases to sustain the quality of produce, and natural ecosystem. This study was first of its kind in Pakistan couple with a lot of limitations of time and resources. Therefore, this study was specifically conducted in two districts. It is highly recommended to the researchers to undertake more research studies to examine the impact of plant clinics in other districts of the Punjab province.

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