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Assessing the Knowledge, Attitude, and Skills of Plant Doctors towards Plant Health Clinics in Pakistan

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ABSTRACT

Infestation of insects, pests and diseases causes a serious decline in the crops, thus for effective crop management plant health clinics were established under the Plantwise initiative by the CABI in developing countries including Pakistan in 2011. Plant health clinics are reported working effectively in Pakistan, however, the knowledge, attitude and skills (KAS) of the plant doctors and their relationship with the increase in yield is not explored, yet. In this study, the KAS of plant doctors is explored by employing a binary regression analysis approach. A total of 353 plant health clinic users selected randomly were interviewed face-to-face from districts Gujranwala and Multan of Punjab province. Descriptive and inferential statistics were applied to the data using Statistical Package for Social Sciences (SPSS). The results indicated that plant doctors had a high level of knowledge, and skills regarding plant protection measures. The knowledge and skills were more inclined towards plant protection as compared to agronomic attributes. The binary regression analysis indicated that the knowledge ($P<0.05$) and skills ($P=0.000$) of the plant doctors were statistically significantly related to the increase in the yield of crops. The increase in yield was likely to increase by 6% and 26% to increase in knowledge and skills of the plant doctors. The attitude was insignificant with the increase in yield ($P>0.05$). Agriculture Extension Department and CABI should jointly organize training programs for the plant doctors to be acquainted with the latest agricultural innovations. Plant doctors should strive towards crop management ensuring sustainable environmental protection and conservation of biodiversity.

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INTRODUCTION

Plantwise is an international initiative undertaken by the Centre for Agriculture and Bioscience International (CABI), especially in developing countries with a focus on improving plant health systems by empowering synergy between stakeholders enabling farmers to prevent and manage pests' infestation precisely. Plantwise aims at supporting male and female farmers, especially small landholders in developing nations to improve pests' management mechanisms, increase crop yield, and eventually pave ways towards achieving food security, alleviating poverty and strengthening livelihoods. Plant clinics aim to put together resources and knowledge of extension and research, input supply

and regulation for the delivery of quick responses to problems related to plant protection (Ranjbar *et al*., 2007).

Under the umbrella of the Plantwise program, a wide network of plant health clinics is organized in over thirty countries across Africa, Asia and America in collaboration with national agricultural advisory services. Plant clinics enabled farmers to manage pest outbreaks effectively by refining the creation, quality and sharing of plant health knowledge. To prevent plants from biotic and abiotic stress factors, plant clinics provide advisory services related to integrated crop and pest management practices which limit the use of chemical pesticides and lead towards sustainable agriculture (Bentley *et al*., 2011).

The concept of plant clinics is based on the human health care system (Bentley, 2009; Danielsen *et al*., 2013). This was first initiated as Global Plant Clinic (Boa, 2009) and is currently promoted through the Plantwise platform. Plant clinics are managed and operated by the plant health extension field staff, who are trained as plant doctors. The plant doctors are imparted with training settled by the experts from CABI, and the training constitutes upon (i) field diagnostic and (ii) plant clinic operation. The training is imparted either by the staff from the CABI or by partnering institutions like agricultural advisory services providers. Once the planned training is completely imparted, the plant doctors are advised to start serving farmers. Plan doctors establish demand-driven plant clinics; upon the visit, farmers can get free, practical and immediate advice on crop management. Farmers visit the set-up plant clinics with the samples of the infected crops and the plant doctors reciprocate with the practical solution and effective recommendations for the management of the observed problems. Setting up plant clinics as consistent rural services has substantial potential to improve farmers' skills to take appropriate action against pests, as proved by a growing body of research and evidence (Hirschfeld *et al*., 2016).

The concept of plant clinics as a pilot project was introduced in Pakistan in 2011 with the support of CABI. District Bahawalpur and Gujranwala were selected for pilot testing and plant clinic activities started in 2012 with the partnership of different public sector departments. There were four national partners, 25 factsheets, and 72 trained plant doctors with 26 plant clinics. Both districts' data was streamlined, and five diagnosis labs were identified for plant clinics' sample testing. In the consolidation phase of plant clinics, desired results were achieved and more plant clinics doctors were trained. 103 plant doctors were from different districts to scale up plant clinics and 52 new plant clinics were established while accumulative 50 factsheets were developed for Pakistan. Data from plant clinics was streamlined on the knowledge bank. Plant clinics were scaled up to a further 8 districts with 5 national partners, 212 new plant clinics were established with 469 trained plant doctors and 16 new fact sheets related to different problems were developed more than 18000 farmers were served (Plantwise, 2015).

In 2015, 130 new plant clinics were established in 13 districts with 428 trained plant doctors and 14 plant doctors' trainers were trained whereas more than 30,000 queries were received from farmers at plant clinics. Plant clinics were scaled up to Sindh province by signing a partnership with the Director of Agriculture Extension Sindh (Plantwise, 2015). Directorate General of Agriculture Extension and Adaptive Research, Punjab provides plant doctor training and technical expertise for developing resource materials whereas the Directorate General of Pest Warning and Quality Control of Pesticides, Punjab also provides plant doctor training and technical expertise for developing resource materials (Plantwise, 2017). Plant clinics were launched in Khyber Pakhtunkhwa (KP) province in November 2018. There were 50 new plant doctors trained in a total of 906 and among them, 874 are working while 131 new plant clinics were established accumulative 1782 while 60 total factsheets were developed (Plantwise, 2018).

Plant clinics are mostly conducted by the extension workers of the public sector in Pakistan like plant health inspectors, field assistants and Agri. Officers. One person (plant doctor) is enough to process queries proficiently and to provide diagnosis and advice (Boa *et al*., 2016). Plant clinics are being run by the public sector agriculture extension department since its start in 2011(Cameron *et al*., 2016) therefore, the knowledge, attitude and skills of the plant doctors remain very critical in motivating farmers to extend their participation in the plant health clinics. In Pakistan, the knowledge, attitude and skills of the plant doctors are not empirically explored, therefore this study was mainly conducted to bridge the literature gap. As the plant health clinics had the aim to increase the

production of the crops, therefore, the knowledge, attitude and skill of the plant doctors with the increase in yield employing the binary regression model approach.

METHODOLOGY

Plant health clinics are operating in the Punjab province; thus this study was conducted in the Punjab province. This study was based on a cross-sectional survey conducted using face-to-face interviews. The Punjab province is the pioneer as the first plant clinic of Pakistan with a joint venture of CABI and the 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). Of the total districts in the Punjab province, this study was conducted in two districts Gujranwala and Multan, which were selected at random. From the study districts, tehsil Multan Saddar and Jalalpur Pir Wala from Multan district and tehsil Gujranwala Saddar and Wazirabad were selected from district Gujranwala employing simple random sampling technique. A total of 15 plant clinics in Gujranwala and 46 in Multan are operating, whereas 15 and 30 plant health doctors are serving, respectively.

A list of participating farmers in the plant health clinics was obtained from the office of the Deputy Director of Agriculture (Extension) district Gujranwala and Multan. This list had a total of 8936 plant clinic user farmers. Whereas there was a total of 4390 users in the study tehsils. This list served as the population of the study. The sample size of the study was 353 plant health clinic users, determined using the online sample size calculator www. Surveysystem.com maintains a confidence level of 95% and a confidence interval of 5. The respondents of the study were chosen randomly.

For the collection of data, an interview schedule was prepared. Before final data collection, the interview schedule was pretested on the 20 farmers, other than the sampled farmers. The pretesting was performed in the district of Faisalabad, where plant health clinics are also functional. Data were collected using a face-to-face interview approach. Collected data were analyzed using Statistical Package for social sciences (SPSS). Descriptive as well as inferential statistics were applied to the data.

The Binary Logistics Regression Model

The binary Logistics Regression model was applied while keeping the knowledge, attitude and skills level of the plant doctors as an independent variable and the increase in yield as the dependent variable in the study. Additive variables of knowledge, attitude and skill, which were binary were constructed using a computation process. An additive score of the knowledge ranged from 18 to 60 and 39 was the cut value, explaining the response <39 was marked 1 referring to low knowledge and >39 was marked 2 referring to high knowledge. In the case of skills, 13-34 was the additive score obtained through computation. The cut value was 23, implying a low skill level (1) when the score was under 23 and a high level (2) when the score exceeds 23. As for as attitude was concerned, the score ranged from 21 to 42. A score less than 31 was referred to as a poor attitude (1) and a score of more than 31 was referred to as a high attitude (2). Whereas the dependent variable increase in yield was converted into binary, referring to the response 1 for an increase in yield and 2 for otherwise. Regression results were explained considering P values and Odds ratios.

RESULTS AND DISCUSSION

The results mainly concerning the demographic attributes of the respondents, knowledge level of plant doctors, skills level of plant doctors, the attitude of plant doctors and the impact of knowledge, attitude and skills of the plant doctors on the increase in yield are explained in this section.

Table 1. Demographic profile 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 (Kilometers)	6.62 ± 4.68
Tenancy status (%)	

Owners	66.3
Tenants	12.2
Owner-cum-tenants	21.5
Participation in 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

Table 1 shows that the average age of respondents was 44.74 years. Respondents had an average education of 5.7 years. The average landholding size appeared to be 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 ages but an ordinary level of education. Farmers seemed highly associated with farming as land size upheld by them was a considerably tremendous experience of farming was reported. More than half of farmers (56.4%) were participants in plant clinics for 4 years, followed by 33% of farmers having participated in plant clinics for 5-6 years. Moreover, 11% of farmers were participants in plant doctors for more than 6 years.

Table 2. Knowledge of plant clinic doctors

Perceived knowledge of plant doctors	Mean± S.D.	Rank
Insect pests' control	4.26±0.924	1
Chemical control of diseases	4.25±0.946	2
Time of spray	4.18±1.038	3
Calculation of dosage of pesticides	4.16±0.898	4
The economic threshold level of insects	4.09±1.140	5
Weed control	4.05±0.953	6
The side effects of pesticide	4.01±0.972	7
The application of pesticides	3.99±1.061	8
Diseases and insects' identification	3.90±0.901	9
The biological control of diseases	3.88±0.883	10
The time of pest attack	3.81±1.334	11
Knowledge related to seed rate	3.68±1.295	12

Scale 1= Very low 2= Low 3= Medium 4=High 5= Very high

Table 2 indicates that the knowledge of the plant doctors regarding insect pest control was ranked first by the farmers ($\bar{X}$= 4.26, Sd=0.924) and the knowledge level was more than the high level. Insect pests exert hefty damage to plant health and the level of crop production eventually. Insects reduce plant performance (Kolb *et al*., 2007). Gagic *et al*. (2016) found a negative effect of pests on yield, followed by Dangles *et al*. (2009) as they reported a significant decrease in the yield of potato crops due to insect pests. In another study, Riedell *et al*. (1999) reported a 58% yield decline in winter wheat due to insect pests. Thus, the management of insect pests and diseases remains a top priority among farmers. Plant doctors knew plant disease management ($\bar{X}$ =4.25, Sd= 0.946), which was ranked 2nd by the farmers through their experience, and observation while working with the plant doctors. Murray and Brennan (2009) documented an 18% decline in yield due to disease infestation. Thus, the management of diseases was deemed inevitable.

Plant doctors were knowledgeable regarding the time of spraying which is regarded as the most effective method of insect pests and disease management. Plant doctors had high knowledge regarding the calculation of pesticide dosage ($\bar{X}$=4.16 Sd=0.898) and economic threshold level of insect pests ($\bar{X}$=4.09 Sd=1.140) as perceived by the farmers participating in plant health clinics. This is deducted from the results that plant

doctors have had a high level of knowledge regarding plant protection as compared to agronomic attributes of the crops like knowledge regarding seed rate which was ranked least ($\bar{X}$=3.68 Sd- 1.295) stating that the knowledge of plant doctors regarding seed rate of different crops was more than medium but tending towards high level. Findings are endorsed by those of Hassan *et al*. (2022), as they found that plant doctors had more knowledge about plant protection areas and crop management against the infestation of insect pests and diseases. The knowledge level of plant doctors regarding the application of pesticides ($\bar{X}$= 3.99, Sd=1.061), identification of diseases ($\bar{X}$= 3.90, Sd=0.901), biological control ($\bar{X}$= 3.88, Sd=0.883) and spotting the time of pest attack rightly ($\bar{X}$= 3.81, Sd=1.334) was measured less than high level.

Table 3. Skills of plant clinic doctors.

Perceived skills of plant clinic doctors	Mean ± SD	Rank
Harvesting of crop	4.17±0.900	1
Sowing methods	4.11±0.845	2
Weed management	4.02±0.913	3
Diseases and pests' control	3.98±0.928	4
Pest control	3.96±0.887	5
Time of irrigation	3.94±0.827	6
Monitoring of insects and diseases	3.75±0.832	7

Scale 1= Very low 2= Low 3= Medium 4=High 5= Very high

Table 3 refers to the skill set of the plant health doctors as perceived by the respondents. The respondents observed that plant doctors were more skillful in sharing ($\bar{X}$= 4.17, Sd=0.900), the information and the right time of harvesting of the crop, which could have helped farmers in reducing the post-harvest losses. Pant doctors were skillful in letting farmers know about the different sowing techniques ($\bar{X}$= 4.11, Sd=0.845), weeds management ($\bar{X}$= 4.02, Sd=0.913), insect pests and diseases management ($\bar{X}$= 3.98, Sd=0.928), irrigation management ($\bar{X}$= 3.96, Sd=0.887) and monitoring the invasion of insects' pests and diseases ($\bar{X}$= 3.94, Sd=0.827), which could have assisted farmers in ensuring the high yield of the crops. Because the plant doctors led advice was mainly concerned with increasing the crops' yield, reducing the cost of production, conserving the environment and eventually ending up with the increased quality of the produce. Findings endorsed by those Rajendran and Islam (2017) accentuated that 97% of the participants of plant clinics implemented the technical advice of the plant doctors. The skills level of the plant doctors ranged between medium and high levels.

Table 4. The attitude of plant clinic doctors.

The attitude of plant clinic doctors	Mean ± SD	Rank
I will continue to contact the plant clinic doctor	3.81±0.679	1
I find the newest methods of pest control with the help of a Plant Clinic doctor.	3.79±0.565	2
Plant clinic experts promote non-chemical methods	3.77±0.819	3
The plant clinic doctor accommodates me efficiently	3.73±0.625	4
Plant Clinic doctor is easily available to me	3.66±0.669	5
Plant clinic doctors have technical knowledge	3.65±0.550	6
The behaviour of the plant clinic doctor is friendly	3.64±0.669	7
I feel that the plant clinic doctor provides useful information.	3.56±0.541	8
Services provided by plant clinic doctors are not better than what I know already	2.42±1.175	9
I think that to avail of plant clinic doctor services is a waste of money.	2.20±0.925	10

Scale 1= Strongly disagree 2= Disagree 3=Neither agree or disagree4=Agree 5= Strongly agree

Table 4 indicates the attitude of the plant doctors and the farmers' perceptions accordingly. Results indicated

that the response of the respondents towards the attitude of plant doctors was found to be varied. Respondents agreed that they will continue their contact with the plant doctors ($\bar{X}$= 3.81, Sd=0.679), as they received information regarding new techniques of pest management ($\bar{X}$= 3.79, Sd=0.565), and they agreed with the role of plant doctors in promoting non-chemical methods of insect pests and diseases management. Adhikari *et al*. (2019) have reported that plant clinics brought a positive change in the attitude of the farmers, especially in the knowledge, and skills regarding insects, pests and disease management. Respondents perceived that plant doctors were efficient ($\bar{X}$= 3.73, Sd=0.625), easily available to interact ($\bar{X}$= 3.66, Sd=0.669), had technical knowledge ($\bar{X}$= 3.65, Sd=0.550), behavior was friendly ($\bar{X}$= 3.64, Sd=0.669), and provided farmers with useful information ($\bar{X}$= 3.56, Sd=0.541), necessary to improve crop health and production. Respondents were in disagreement with the statements that plant doctors were not better ($\bar{X}$= 2.42, Sd=1.175), and their services were waste of money ($\bar{X}$= 2.20, Sd=0.925). This can be deduced from the results that the attitude of the plant doctors was positive towards the plant health clinics and facilitation to the farmers.

Table 5. Binary Logistics Regression Estimates.

KAS	B estimate	Standard error	OR	P value
Knowledge	0.906	0.364	6.188	0.013*
Skills	1.825	0.347	27.694	0.000**
Attitude	0.639	0.379	2.834	0.092^{NS}

Dependent Variable: increase in yield Independent Variable: Knowledge, Attitude, Skills

Table 5 indicates the results of the binary logistics regression analysis. An increase in crop yield was the dependent variable whereas knowledge, attitude and skills of the plant health doctors were the independent variables in the model. Three hypotheses are tested using binary logistics regression analysis.

H_0: Knowledge of the plant doctors was related to the increase in the crop yield

Results given in Table 5 indicated that knowledge of the plant doctors was statistically significantly related to the increase in crop yield (P<0.05). This indicates that an increase in crop yield was more likely when the plant doctors had more knowledge. This is reflected in the table that with the increase in knowledge of plant doctors, 6 times increase in the crop yield was likely (Odds Ratio: 6.188; P=0.013).

Considering the knowledge, farmers put their knowledge into practice and adopt sustainable and protective measures epically when applying pesticides (Dewi *et al*., 2022). Macharia *et al*. (2013) and Mubushar *et al*. (2019) have also associated knowledge with the safe application of pesticides. Knowledge of the plant doctors about the agronomic and plant protection-related aspects, that is shared among farmers can bring change in the behaviour of farmers which eventually guarantees an increase in crop yield. Thus, the hypothesis is accepted.

H_0: Skills level of the plant doctors was related to the increase in the crop yield

As confirmed in Table 5, this hypothesis was accepted as the skill level has a highly statistically significant association with the increase in crop yield. The relation indicated that with the increase in skills of plant doctors, the increase in yield was likely by 26% (Odds Ratio: 27.694; P= 0.000). Skills of the plant doctors regarding plant production, plant protection and devising appropriate strategies for insect pests' management are regarded as key to increasing the yield of the crop. The skillful application of the input in the crop not only increases the production but also curtails the cost of production and conserves the natural resources and environment.

H_0: The attitude of the plant doctors was related to the increase in the crop yield

Table 5 shows that the attitude of the plant doctors was statistically insignificant with the increase in yield (P=0.092), thus the hypothesis is rejected and the null hypothesis is accepted that the attitude of the plant doctors was not statistically related to the increase in yield. This explains that the increase in yield was more relevant to the knowledge and skills of the plant doctors which can assist farmers in making wise decisions regarding crop management.

CONCLUSION AND RECOMMENDATIONS

Plant protection is inevitable especially when the achievement of a high yield of crops is deemed necessary. Technical advice on plant protection and crop management is directly associated with the yield increase. Plant health doctors were knowledgeful, and skillful and had a positive attitude towards the role of plant health clinics in increasing crop yield. Plant health doctors had high knowledge regarding plant protection areas like insect pests and diseases management, spraying techniques, the economic threshold level of insects and pests, optimization of pesticide dosage and biological control methods of insect pest management. Similarly, the plant doctors were skillful in sharing information timely, sowing techniques, weeds management, insects' pests and diseases management and irrigation management. Plant doctors have a high level of knowledge regarding plant protection as compared to agronomic attributes of the crops like knowledge regarding seed rate. For the farmers, the attitude of the plant doctors was favourable, thus farmers preferred to continue contacting them for their efficiency, availability, technical knowledge, and friendly behaviour. The knowledge and skill level of the plant doctors was statistically significantly related to the increase in yields as compared to the attitude which was non-significant. This implies that the knowledge and skills level of doctors is the right avenue to be focused through education and training ensuring institutional collaboration. The Agriculture Department and CABI should jointly organize training programs for the plant doctors to be acquainted with the latest agricultural innovations. Plant doctors are more focused on plant protection, thus they should be trained and supported to facilitate the farmers regarding plant production, agronomic attributes and crop nutrition. Plant doctors should be shifting their motive towards crop management ensuring sustainable environmental protection and conservation of biodiversity.

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