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Assessing the Impact of Quinoa Cultivation Adopted to Produce a Secure Food Crop and Poverty Reduction by Farmers in Rural Pakistan

Ejaz Ashraf, Raheel Babar, Muhammad Yaseen, Hafiz Khurram Shurjeel, Nosheen Fatima

Abstract**—**Main purpose of this study was to assess adoption level of farmers for quinoa cultivation after they had been taught through training and visit extension approach. At this time of the 21st century, population structure, climate change, food requirements and eating habits of people are changing rapidly. In this scenario, farmers must play their key role in sustainable crop development and production through adoption of new crops that may also be helpful to overcome the issue of food insecurity as well as reducing poverty in rural areas. Its cultivation in Pakistan is at the early stages and there is a need to raise awareness among farmers to grow quinoa crops. In the middle of the 2015, a training and visit extension approach was used to raise awareness and convince farmers to grow quinoa in the area. During training and visit extension program, 80 farmers were randomly selected for the training of quinoa cultivation. Later on, these farmers trained 60 more farmers living into their neighborhood. After six months, a survey was conducted with all 140 farmers to assess the impact of the training and visit program on adoption level of respondents for the quinoa crop. The survey instrument was developed with the help of literature review and other experts of the crop. Validity and reliability of the instrument were checked before complete data collection. The data were analyzed by using SPSS. Multiple regression analysis was used for interpretation of the results from the survey, which indicated that factors like information/ training, change in agronomic and plant protection practices play a key role in the adoption of quinoa cultivation by respondents. In addition, the model explains more than 50% of variation in the adoption level of respondents. It is concluded that farmers need timely information for improved knowledge of agronomic and plant protection practices to adopt cultivation of the quinoa crop in the area.

Keywords**—**Farmers, quinoa, adoption, contact, training and visit.

I. Introduction

FARMERS play a key role in sustainable crop development and production. The goals of self-reliance in agriculture and reducing poverty in rural areas of Pakistan would not be achieved without their contribution. Extension services are always at the fore front to transfer modern agricultural knowledge and production technology to farmers for improved agricultural practices to meet the growing food requirements of the world population. Extension services around the world are continuously engaged for bringing revolutionary changes in agricultural practices for sustainable crop production. Many developmental programs in different parts of the world were applied to overcome the problems of farmers, and so do in countries like Pakistan. Since independence, a number of programs have been tried in Pakistan; however, studies have shown that each one of them was abolished after a certain time. Each of these programs has its own strengths and weaknesses in the field.

A training and visit (T&V) program was introduced in more than 50 developing countries of the world by the World Bank in the mid-seventies [1]. According to a research study conducted by [2] in Pakistan, T&V was first introduced in 1979 with the objectives that it will affect both the quantity and quality of extension advisory services which on the other hand will affect the farmer's technical knowledge and skills to increase crop production. The demographic structure, climatic conditions and eating habits of people around the globe are changing so rapidly. Farmers are forced to produce more food crops for constantly growing population of the world. Consequently, to meet future food requirements, farmers have to divert their attention toward crops which give maximum yield in a shorter possible time. The quinoa (KEEN-WAH) crop has the potential not only to overcome the issue of food insecurity, but also to reduce malnutrition. In addition, farmers could increase their income to reduce poverty in the area. In Pakistan, quinoa cultivation is at early the stage. The farming community needs research-based awareness and advisory services for the cultivation of the quinoa crop.

Quinoa (*Chenopodium quinoa* willd) is a native food crop to the Andes Mountains of Bolivia, Chile, and Peru regions, dating back 5,000 years AD. Quinoa means "mother grain" in the Inca language, and has been cultivated for thousands of years in the mountains of South America [7]. Its extra ordinary high nutritional values brought recent international attention on its cultivation as a top-most priority in the world to maintain future food security [8]. The seed is resistant to drought and frost and is frequently cultivated in poor soils. The Incas appreciated its high nutritional value and acceptance in milling. Crops like quinoa, made it possible for the rural population to take advantage of the nutritional value and

Ejaz Ashraf is Assistant Professor, Department of Agricultural Extension & Rural Development, Faculty of Agriculture, University of Sargodha, Sargodha-Punjab, Pakistan (phone: 0092-323-500-4155, e-mail: ejazashraf60@hotmail.com).

Raheel Babar is Associate Professor, Department of Range Management, Forestry & Wildlife, Balochistan Agricultural College, Quetta-Balochistan, Pakistan.

Muhammad Yaseen is Assistant Professor and Nosheen Fatima is M.Sc. degree student, Department of Agricultural Extension & Rural Development, Faculty of Agriculture, University of Sargodha, Sargodha-Punjab, Pakistan.

Hafiz Khurram Shurjeel is Ph.D. candidate in the Department of Agricultural Entomology, Faculty of Agriculture, University of Sargodha, Sargodha-Punjab, Pakistan.

exceptional balance among oil, protein and fats. This crop may also change the socio-economic status of rural communities of the area.

In Peru, there exist serious dietary problems, particularly among preschool children. The problem is most severe in rural areas where the poverty level is very high. According to different research studies, nearly 50% of the population is below poverty line. Due to the lack of awareness and prevailing poverty, the local population does not enjoy enough nutritious food. The highly nutritive, native crop quinoa is not a staple crop in urban areas. In comparison, proteins contents of quinoa are higher than other cereals such as 14% to 16%, and provide all standard characteristics of amino acids desirable for human consumption [6]. To achieve the goal of a food secure society in the future, cheap and cost effective food processing technologies need to be introduced at a small scale level for general use to process quinoa type crops and to produce hygienic and nutritive food items [4].

Quinoa seeds have an excellent nutritional value and the average protein in quinoa is higher than in other common cereals like wheat, rice and oats. The protein content in the seeds of quinoa can vary from 8% to 22%. Quinoa contains all the essential amino acids that body needs and the grain has a high content of the amino acid lysine, which is not excessively abundant in vegetables. Quinoa is also high in the amino acid methionine, which makes it a good complement to legumes, which are low in lysine and methionine [5]. Quinoa is rich in phenol compounds and has high contents of dietary fiber. Average fat contents in quinoa are higher than in other crops such as oats, wheat and rice. Quinoa has very similar contents of fatty acids. The saturated fatty acids are 22.7 % of methyl ester mixture in quinoa, which means, the amount of unsaturated fatty acids is 77.3%. Quinoa grains have excellent balance between protein and fat. This crop is also referred as a "pseudo-cereal", since it has broader leaves and cultivated as a grain crop. In one study, [9] described that Andean cereals, like quinoa, do not belong to the grass family and are therefore not real cereals, since the crop produces seeds that can be milled into flour and used as cereal crops. Quinoa seeds are larger and generally used as boiled food; however, it is also used as an ingredient in other food products.

II. Material and Methods

In June, 2015 a T&V out-reach program was initiated to train local farmers for the cultivation of the quinoa crop in the district of Sargodha, Punjab-Pakistan. After six months of the program, a study was carried out in December 2015 in the same district to assess the impact of the program.

A. Purpose of the Study

The overall purpose of the study was to determine the impact of the T&V out-reach program for the adoption of improved farming practices among local farmers for quinoa cultivation in the district of Sargodha, Punjab-Pakistan.

B. Research Objectives of the Study

Research objectives were designed to:

1) Describe the demographic characteristics of the respondents.
2) Evaluate the information or training sources of the respondents.
3) Study the adoption level of respondents by specific cultivation practices of the quinoa crop.
4) Assess the impact of recommended agronomic practices on the adoption level of the respondents through the T&V approach.
5) Determine the impact of recommended plant protection practices on the adoption level of the respondents through the T&V approach.

C. Population and Sample

The target population was all motivated and interested farmers of the district of Sargodha. A list of farmers based on the selection criteria specified by the researchers for the sample was prepared with the help of the Extension services office of Sargodha District. Initially, 80-contact farmers were randomly selected to participate in the T&V Out-reach program from the prepared list. Bi-weekly visits were arranged for contact with the farmers, who were then asked to train a further 60 farmers (non-contacted) who were living in their neighborhood and did not get have the opportunity to participate in the program. Hence, the final sample size for the survey study was 140, which included both the contacted and non-contacted farmers.

D. Research Design and Instrumentation

A cross-sectional survey research design was used for the study. A blend of structured and semi-structured survey instruments was prepared for the selected factors such as demographic characteristics, knowledge of the respondents in agronomic and plant protection practices learned from the T&V program and adoption of quinoa cultivation practices as recommended through the program. The contents and face validities of the instrument were checked through a panel of experts of Extension Education. Following the recommendations of the panel of experts, the instrument was revised and tested with a sample of 20 respondents in a pilot study. The reliability of the instrument was also checked by computing the value of Cronbach's alpha, which was 0.80 for factors of the knowledge level of the respondents in agronomic, plant protection practices and for the adoption of recommended quinoa cultivation practices through T&V.

E. Data Collection and Analyses

Data were collected through a survey instrument. The collected data were statistically analyzed for drawing the necessary results and conclusions. Both descriptive and inferential statistical techniques were used for interpretation of the data for the target population of quinoa producers of Sargodha District.

III. Results

The collected data were analyzed using Statistical Package for Social Sciences and the results of the study described in ensuing sections.

A. Demographic Characteristics of Quinoa Growers

Characteristics such as age, education and experience, status of the farmer, farm size and frequency of the Extension contact were examined during the study, since these are the variables which play a significant role in defining any farm population. The results of the demographic characteristics of the respondents have been summarized in Table I.

TABLE I
Distribution of the Respondents Regarding Their Demographic Characteristics

Demographic characteristics	Frequency	Percentage
Farmer's age (years)		
Up to 30	33	23.57
31-40	36	25.71
41-50	38	27.14
51-60	21	15.00
61-70	6	4.29
70-80	6	4.29
Educational level		
Illiterate	10	7.14
Primary (5-schooling years)	21	1500
Middle (8-schooling years)	35	25.00
Matriculation (10-schooling years)	28	20.00
Intermediate (12-schooling years)	23	16.43
Graduate (14-schooling years)	15	10.72
Post-Graduation (16 or more schooling years)	8	5.71
Farming Experience (years)		
Up to 10	23	16.43
11-20	49	35.00
21-30	37	26.43
31-40	14	10.00
41-50	12	8.57
51-60	4	2.86
61-70	1	0.71

The data in Table I for the demographic characteristics showed that the average age of the respondents was 42 years. It is also observed that many of the farmers have an educational level from Primary to Intermediate. In addition, 35% of the respondents have had experience ranging from 11 years to 20 years.

B. Information Sources and Farm Characteristics of Quinoa Growers

Other characteristics such as farm size, status of farmers, frequency of Extension contact and knowledge or information and training sources for quinoa cultivation were also evaluated during the study. Table II shows the desired results from the collected data.

Mixed results were observed for the different farm characteristics, Extension contacts and information/training sources used by the respondents to increase knowledge or awareness for quinoa cultivation. The average farm size was 16.92 acres, and almost 44% of the respondents hold their own agricultural lands.

TABLE II
Distribution of the Respondents Regarding Their Farm Characteristics and Extension Contacts

Farm characteristics	Frequency	Percentage
Land status of the Farmers		
Landlord	62	44.28
Tenant	52	37.15
Lease holder	26	18.57
Farm size of the farmers (acres)		
1-10	45	32.14
11-20	60	42.85
21-30	23	16.43
31-40	4	2.86
41-50	4	2.86
51-60	4	2.86
Extension Contact		
Yes	115	82.10
No	25	17.90
Frequency of Extension contact in a month		
0	25	17.90
1	8	5.70
2	43	30.70
3	56	40.00
4	8	5.70
Village is accessible by paved road		
Yes	104	74.30
No	36	25.70
Information/knowledge about Quinoa before T&V		
Yes	33	23.60
No	107	76.40
Sources used for Quinoa Knowledge/information/training		
Radio	24	17.10
TV	18	12.90
Agricultural Journals/magazines	18	12.90
Extension Information Services	80	57.10
Ever attended any workshop/conference/seminar for Quinoa		
Yes	39	27.90
No	101	72.10
Recommended sowing method by experts of T&V		
Broadcast	99	70.70
Drill	16	11.40
Both	25	17.90
Recommended irrigation type by experts of T&V		
Canal	64	45.71
Tube-well	29	20.72
Both	47	33.57

The results show that nearly 82% of the respondents have time-to-time contact with the extension field staff in the area, with 40% of the respondents saying they have at least three contacts a month with the Extension department to get advice and the latest crop improvement information. The results also indicated that many of the villages, nearly 74% in the area, have good paved road communication and have access to urban markets. On the other hand, almost 76% of the respondents reported that they did not know about quinoa cultivation before he current training and visit Out-reach

program even though a majority of the respondents (57.10%) use the Extension information service as a source of information/training or knowledge for any new crops like quinoa. In addition, only a small number of respondents, nearly 28%, have access to any kind of workshop, seminar or conference for quinoa cultivation depending upon their interest, contacts and educational level. The results also indicated that more than 70% of the respondents used the broadcast seed sowing technique and nearly 45% respondents used canal water for irrigational purposes for quinoa cultivation.

C. Adoption Level of Respondents by Recommended Characteristics of Quinoa Crop

After the T&V Out-reach program, the adoption level of respondents was also evaluated in the follow up survey to determine how well the respondents have adopted quinoa cultivation practices based on its specific characteristics. The results are presented in Table III.

TABLE III
PERCENTAGE OF THE RESPONDENTS REGARDING THEIR ADOPTION LEVEL OF QUINOA CULTIVATION

Recommendation of T&V program	Not adopted yet	Laggard	Late majority	Early majority	Innovator
Recommended as a new crop.	42.14	1.42	21.44	20.71	14.29
Recommended use of fertilizer.	22.86	5.00	23.57	35.71	12.86
Recommended weed control.	33.57	12.14	23.57	27.14	3.58
Recommended source of nutritional values.	22.86	12.86	30.71	25.71	7.86
Recommended as additional source of income.	1.43	17.14	19.29	43.57	18.57
Recommended as staple food.	7.14	22.14	31.44	27.14	12.14
Recommended sowing practices.	2.14	16.44	20.71	40.00	20.71
Recommended cultivars.	7.86	17.14	21.43	28.57	25.00

The results from Table III indicated considerable diversity in the response of the growers showing that 42% of the respondents have not adopted quinoa cultivation at all. However, more than 43% of the early majority of the respondents adopted quinoa cultivation to have an additional source of income. On the other hand, only 25% of the respondents adopted quinoa as recommended cultivars of a new food crop.

D. Impact of Agronomic and Plant Protection Practices on Adoption Level of Respondents

The impact of the knowledge level of agronomic and plant protection practices gained from T&V Out-reach program by the respondents was evaluated through applying a complete regression model. The model was: $y= \alpha+\beta_1 x_1+\beta_2 x_{2+} \beta_3 x_3$, where y=Adoption of recommended specific practice of quinoa cultivation, α=Constant/slope in the regression model, β_1=Information/training sources available to the respondents, β_2=Knowledge level of the respondents in agronomic practices, β_3=Knowledge level of the respondents in plant protection practices, x_i=Observable change in the knowledge level of the respondents in agronomic and plant protection practices and information/training sources that may bring overall change in the dependent variable of adoption of recommended specific Quinoa cultivation practice. The results of the regression model applied are given in Table IV.

TABLE IV
CO-EFFICIENTS OF THE REGRESSION MODEL

Model	Unstandardized Co-efficient		Standardized Co-efficient	t	Sig.
	B	Std. Error	Beta		
(Constant)	0.908	2.272		0.400	0.690
Info. Sources	0.868	0.268	0.201	3.234	0.002
Knowledge of agronomic practices	0.570	0.089	0.517	6.386	0.000
Knowledge of plant protection practices	0.329	0.132	0.199	2.493	0.014

[a]Dependent Variable: Adoption level,[b]R^2 = 0.513; Adj. R^2 = 0.502

The model was statistically significant *F (3, 136) = 47.738 p<.05* and accounted for 51.3% of the variance in dependent variable of adoption level. The results from Table IV indicated that information/training sources, the knowledge level of the respondents in agronomic and plant protection practices were strong predictors in the model and played a significant role in measuring the adoption level of the respondents. Table IV also emphasized the standardized coefficients (β) for the three main predictors that showed the net effect on the adoption level which is associated with one unit change in information/training sources, the knowledge level of the respondents in agronomic and plant protection practices. Similar findings were also concluded by [3] in his study that only high level information/training could bring change in the knowledge level of the respondents.

IV. DISCUSSION

It is evident from the data that farmers of the age group 41-50 years are taking more interest in quinoa cultivation in the district of Sargodha, Pakistan. This is because the majority of the farmers have almost 11 years to 20 years of farming experience in the area. They have good knowledge about the soil and environmental conditions required for the agricultural practices for any new crop. The majority of farmers in the study have their own agricultural land, which is another important reason for taking an interest in cultivating new crops like quinoa. Ironically, many of the farmers included in the sample have excellent contact with Extension department field staff and are being visited at least three times a month. This happens because of the initiation of university-based out-reach extension program in the area.

The data also indicated that more than 74% of the villages in the study area are connected with paved-road network which further reflects an interest from Extension services agencies for taking care of knowledge transfer at door steps of the farmers. However, many of the farmers did not have any

information or knowledge regarding quinoa cultivation before introducing the T&V Out-reach program, although they are consistently in contact with extension field staff for advisory services. It is assumed that extension field staff may not provide information regularly regarding new crops or improved agricultural practices other than routine information for inputs supplies, irrigational issues and animals' problems. These kinds of problems created opportunities for introducing T&V programs by different agencies for providing timely information regarding introduction of new crops or technology. It is also important to mention that farmers participate in these activities at their own will, and with open hearts and minds and produce encouraging results at the end of the program. During the T&V program, farmers were encouraged to use the broadcast method for sowing the quinoa seeds in leveled, well-drained seedbeds to avoid water logging. Farmers reported that they have enough canal water for 3-4 or even more irrigations during cropping season.

Later on, a survey was conducted to evaluate the impact of information/training or knowledge level sources, agronomic and plant protection practices taught during the T&V Out-reach program on the adoption level of quinoa cultivation of the respondents. The results from the evaluation of the adoption level factor indicated that more than 43% of the respondents had decided to adopt quinoa cultivation because it could add extra income to their family budget, since it has high return price in the market compared to wheat and rice. In addition, regression analysis was applied to determine the role of independent variables such as information/training sources, knowledge gained for agronomic and plant protection practices during the T&V program on the dependent variable of the adoption level of the respondents. The results indicated that all three independent variables were strong predictors and explained good amount of variation in the dependent variable of the adoption level of the respondents. Hence, it is said that proper information delivery and training in agronomic and plant protection practices may be helpful in adoption of quinoa cultivation by respondents and could provide a secure food crop which would also help to reduce poverty levels in rural areas of the country in the future.

V. Conclusion and Policy Implications

It is concluded that proper information (research-based knowledge) delivery and training in agronomic and plant protection practices may be helpful in changing the adoption level of respondents, and hence, opens alternative routes for secure food crops and would also provide an opportunity to reduce poverty levels in rural areas of the country in the future. In addition, agricultural policy makers must divert focus to promote quinoa cultivation in the country. Farmers' need government support and quality seeds of quinoa for cultivation. Additional farm size needs to be allocated for quinoa cultivation with other seasonal crops.

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