

Assessing the Awareness of Different Management Practices Among Apple Growers in Ziarat

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Abstract

Apple is the third largest fruit crop in the country, following citrus and mango, covering a significant area in Baluchistan and playing a crucial role in local income generation and the national economy. This study aimed to assess the awareness levels of respondents regarding management practices. A multi-stage sampling technique was employed, with tehsil Ziarat purposively selected. Four randomly chosen union councils and 12 villages within these councils were included, totaling 120 apple growers interviewed for data collection. The results revealed limited awareness among respondents about mechanical land preparation and the hexagon or triangular planting systems for apple cultivation. Red delicious variety dominated due to market demand, with lesser-known varieties like Mashadi and Amri being less cultivated. Awareness about irrigation methods such as furrow and drip irrigation, and fertigation practices, was also low. Similarly, knowledge about equipment like backpacks and compressed air sprayers was lacking, with manual picking being the most common method. There is a critical need to enhance the knowledge of apple growers through organized extension activities. Additionally, government subsidies on inputs are necessary to equip farmers with the latest agricultural technologies.

Keywords: Apple, Assessment, Awareness, Management

Introduction

In Pakistan, fruits are valued as protective food and a rich source of minerals and vitamins. Apple is a valuable fruit crop by production and it is an indigenous fruit plant growing from 2500 to 6500 feet above sea level and also gives flowers during the spring and flowers occur in clusters at the end of a 1-3-year-old woody shoot called a spur. The production of deciduous fruit (mainly apples) in Baluchistan has exceptional importance among other fruit plants. Despite climatic conditions Baluchistan as compared to other provinces is more suitable for the production of apples. Therefore, apple is grown in hilly areas of Baluchistan (Govt. of Balochistan., 2016).

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Apple is the third most important fruit crop in Pakistan, following citrus and mango. The country ranks as the 24th largest producer of apples globally and 34th in terms of area dedicated to apple cultivation. Baluchistan is the leading apple-producing province, contributing significantly to Pakistan's total apple production, with Khyber Pakhtunkhwa (KPK) accounting for 25% of the national output (GOP, 2021). In the 2018-2019 period, Pakistan's apple production reached 616,748 tons, with Baluchistan alone producing 482,819 tons from an area of 88,807 hectares (Khan et al., 2022; GOP, 2021).

The primary apple-growing regions in Pakistan include Baluchistan, KPK, and the northern areas. Within Baluchistan, apples are predominantly cultivated in districts such as Quetta, Ziarat, Pishin, Kalat, Loralai, and Zhob, where the dry and cool climatic conditions and higher altitudes are ideal for apple growth (Aziz et al., 2013). This climate advantage makes apple cultivation preferable for farmers in the region. Well-known apple varieties grown in Pakistan include Shin-Kolu (golden delicious) and Tur-Kolu (red delicious), noted for their color and aroma (Noonari et al., 2015).

Baluchistan is one of the greatest (western) growing belts in the country. It provides Baluchistan's marketable apple production for being comparatively cool and short growing period. In Pakistan, the province of Baluchistan is the main producer of apple production although KPK stands in second position paying almost (15%) of domestic apple growth (Govt. of Balochistan., 2016). It is one of the favorite fruits of our nation for its dulcet flavor, tender taste, aromatic and nutritious nature, and many uses. Along with a rich source of vitamins (A, B, and C), it contains an appalling sum of carbohydrates, proteins, and minerals, and Pakistan is blessed enough to be gifted with extensive kinds of agro-climatic situations that allow the production of both hot and moderate fruits. The best climatic conditions and soil for apple farming abound in most of the mountainous ranges of KPK and Baluchistan provinces (Muhammad et al., 2011).

Study Significance

Effective pest management and improved farming practices are crucial to overcoming production losses and increasing income. Globally, apples are susceptible to numerous diseases caused by fungi, bacteria, and other pathogens (Grove et al., 2003). Farmers use various types of insecticides and pesticides to combat insect-pest infestations. While these measures are sometimes effective, they are not always successful (Siddiqui et al., 2017). Similarly, farmers adopt various practices based on their mentality and previous experiences. Therefore, it was necessary to investigate the awareness of different management practices among apple growers in Ziarat, as this awareness influences the selection of specific practices.

Objectives

1. To identify the socioeconomic attributes of the apple growers.
2. To assess the awareness of apple growers regarding different management practices.
3. To compile recommendations for apple growers based on the findings of the study.

Methodology

Study Area and Population

The study was conducted in the purposively selected district of Ziarat. It consists of two tehsils, Ziarat and Sinjawi. Ziarat is one of the main apple-growing districts in Baluchistan where apple fruits are of premium quality and have a high market value over other districts. Over 4,400 acres in and around Ziarat consist of apple orchards which is more in proportion as compared to other

districts (Adnan et al., 2017). All apple growers residing in the study district constitute the population of the study.

Sampling

Multi-stage sampling technique was used for data collection. Tehsil Ziarat was selected purposively for the study. Out of seven union councils four union councils were selected randomly. Out of four selected union councils, 12 villages were selected randomly. From each selected Village 10 apple growers were selected randomly thus making the sample size 120 apple growers.

Data Collection Tools

Keeping in view the objectives of the study a well-structured interview schedule was developed for data collection. The interview schedule was prepared under the supervision of extension experts from the Institute of Agricultural Extension, Education and Rural Development, University of Agriculture Faisalabad.

Data Collection

Data were collected through personal, face-to-face interviews. The questions were explained to the respondents in their local language to avoid any confusion while answering.

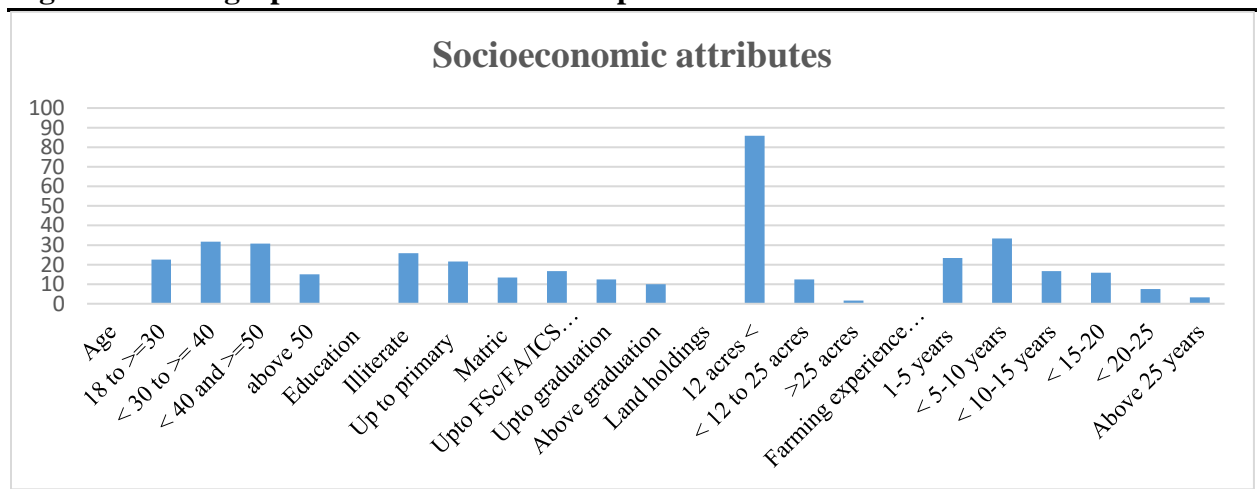
Data Analysis

The collected data were analyzed using computer-operated statistical software named the Statistical Package for the Social Sciences (SPSS). Various statistical values were computed, including percentages, means, standard deviations, weighted scores, and rank orders of the data.

Results and Discussion

In this section, the researcher has discussed all the outcomes and results of the study.

Figure 1: Demographics attributes of the respondents



The data revealed that about 32% of respondents were aged between 31 and 40 years, while 15% were over 50 years old. This indicates a lower involvement of youth in farming practices, aligning with Ashraf and Shabeer (2002), who found that 54% of respondents were middle-aged (35-45 years). A similar study conducted by Noonari et al. (2015) in Mustung district of Baluchistan

yielded different results from the present study. The findings showed that in the age group of 21-30 years, 21.66% of apple farmers fell into this category. For the age group of 31-40 years, the percentage was 25%, and for the age group of 41-50 years, it was 31.66%. Farmers aged over 50 years constituted 21.66% of the apple farmer population.

Education is crucial in the adoption of improved farming practices, as communication with educated individuals is easier for extension agents (Sadaf, 2005). The study's data showed that 26% of respondents were illiterate, and only 10% had education beyond graduation, highlighting low educational levels as a significant factor for limited awareness. These findings are consistent with Murtaza et al. (2003), who reported that 40% of farmers were illiterate.

Land holding size, which refers to the part of the land used for farming and livestock, also influences the adoption of modern practices. Larger farms are more likely to adopt innovations (Hussain, 1989). The study categorized orchard sizes into small, medium, and large, finding that 86% of respondents had small land holdings, 12% had medium-sized orchards (12 to 25 acres), and 2% had large orchards. These findings align with Siddiqui et al. (2006), who found that 63.94% of farmers had small land sizes.

Regarding farming experience, 23% of respondents had 1-5 years of experience, 33% had 5-10 years, 17% had 10-15 years, 16% had 15-20 years, 7% had 20-25 years, and only 3% had over 25 years. These findings match Noonari et al. (2015), who reported that 41.66% of apple growers had up to 10 years of farming experience.

Framers Awareness Regarding Different Management Practices

Different questions were asked from apple growers to check the awareness level of recommended modern practices such as preparation of land, planting methods, varieties of apple, irrigation method, irrigation requirement, fertilizer application, method of spraying, cultural control, and harvest techniques.

Land Preparation Techniques

Land preparation provides the optimal soil conditions necessary for successful root establishment, which in turn ensures balanced nutrition uptake for robust crop production. It is a critical step before cultivating vegetables and fruits, significantly influencing farm outcomes. Apple growers were surveyed to assess their awareness of recommended management practices related to land preparation and other agricultural techniques.

Table 1: Distribution of respondents according to their awareness level regarding different management practices

Land Preparation	Mean	S.D	WS	RO
Mechanical preparation	2.45	.951	295	1
Manual Preparation	.183	.673	22	2
Planting Methods				
Square system	2.61	.610	314	1
Contour system	.225	.738	27	2
Hexagonal system	.000	.000	0	3
Triangular system	.000	.000	0	4
Varieties of apple				
Red delicious	2.04	1.18	345	1
Katja	1.83	1.25	220	2

Golden delicious	.475	1.068	57	3
Mashhadi	.333	.946	40	4
Irrigation methods				
Channel system	2.458	.696	295	1
Flooding or common method of irrigation	.600	1.095	72	2
Channel-basin system	.233	.682	28	3
Modified-basin system	.066	.360	8	4
Furrow irrigation	.016	.182	2	5
Drip irrigation	.000	.000	0	6

The data regarding recommended land preparation techniques indicates that respondents were well aware about mechanical preparation of land having weighted score 295 and mean value 2.45 and manual preparation was ranked second position having 22 weighted score and .183 mean value.

Considering about different recommended sowing methods, depicted that awareness about square system was most prevailed in the study area having weighted score 314 and 2.61 mean value 2.61, contour system was ranked second having weighted score 27 and mean value 225. It was cleared that majority of the farmers were using square system and contour system in planting apple crop.

The data regarding different varieties selection indicated that most of the respondents were aware about Red delicious variety of apples and this response having weighted score 345 and mean value 2.04, awareness about Katja variety was ranked on second position having weighted score 220 and mean value 1.83. While least of the respondents were aware about Amri variety of apples and it was ranked on fifth position having weighted score 36 and mean value .300. It was explored that red delicious was being used extensively because of better results as compared to other varieties. Murtaza and Thapa (2017) ranked similar varieties in their study conducted in Baluchistan, according to them Red delicious and Katja were top varieties preferred by apple growers. The findings are in the line with (Shah et al., 2006) who has mentioned that most grown apple varieties in Baluchistan are Red delicious, Golden delicious and Katja because of having good marketing value.

The data regarding different recommend irrigation techniques indicates that most of respondents were aware about channel irrigation system with weighted score 295 and mean value 2.458 and most of the respondents were not aware about drip irrigation in the study area.

Fertilizer Application

Fertilization plays a crucial role in enhancing agricultural productivity and product quality by providing essential nutrients. Fertilization is essential for agricultural yields, its improper use and management can exacerbate environmental pollution issues (Savci, 2012). Questions were asked about fertilizer application practices, and the responses of growers are outlined below.

Table 2: Distribution of respondents on the basis of their awareness regarding different techniques of fertilizers application

Fertilizer application	Mean	S.D	WS	RO
Macro-fertilizer	2.516	.798	302	1
Micro-fertilizer	2.491	.869	299	2
Composting	2.208	1.099	265	3
Farm yard manure	2.183	.934	262	4
Ground application (macro fertilizer)	2.183	1.195	262	5
Ground application (micro fertilizer)	2.083	1.112	250	6
Fertigation (macro fertilizer)	.291	.803	35	7
Fertigation (micro fertilizer)	.283	.831	34	8

Data of fertilizer application given in above table, ranked on the base of weighted score value. Most of the respondents were aware about macro fertilizer having maximum value of weighted score 302, so it ranked at first position. Micro fertilizers were ranked on second position, awareness about composting was ranked on third position, farm yard manure was ranked at fourth position ground application of macro fertilizer on fifth and ground application of micro fertilizer ranked at sixth position. During discussions with the farmers, it was revealed that they were applying fertilizers based on their existing knowledge. Some farmers favored the use of macronutrients, while others preferred applying micronutrients. As reported by Amiri et al. (2008) study conducted in Iran, they were in favor of foliar application of nutrients, that can be more efficient than soil application. They have applied Zinc and Nitrogen in with different concentration. However, they recommend a combination of both soil and foliar applications for optimal nutrient management in apple trees. A study conducted in India by Kumar et al. (2016), they advocated for fertigation, noting that it significantly increased apple fruit yield compared to conventional fertilizer application methods. From this comparison, one may conclude that apple growers use different methods of fertilizer application according to their soil conditions and personal preferences.

Spraying Methods

Spraying method plays a vital role in efficiency of pesticide and control of insects/pests. It is important to choose the right method against the affected plants. As stated by Travis et al. (1987), the application of pesticides is essential for ensuring an adequate food supply and high-quality food products. However, their use inevitably leads to a series of side effects on plant production. Number of question were asked from farmers to probe out their awareness level about different recommended spraying methods for apple plants.

Table 3: Distribution of respondents according to their awareness regarding methods of spraying

Methods of spraying	Mean	S.D	Weighted score	Ranked order
Power tractor sprayer	2.916	.616	350	1
Hydraulic Sprayer	.775	1.687	93	2
Backpack sprayer	.216	.735	26	3
Compressed air sprayer.	.025	.273	3	4

The data regarding awareness level about different spraying methods shows that most of the respondents were aware about tractor sprayer and responses regarding this category was ranked on first position with weighted score 350 and mean value 2.916 while least respondents were aware about compressed air sprayer due to that reason it was ranked on fourth position with weighted score 3 and .025 mean value. It indicated most the farmers were using power tractor sprayer because of having high power and easy to manage. Different type of sprayers reported by An et al. (2020), they favored the tower sprayer in apple orchard. According to them, its scientifically designed structure helps protect the soil and reduces environmental pollution. Some method of spraying is not suitable for humans as well as for soil and environment as reported by Directives (2009), the application of pesticides is essential for ensuring an adequate food supply and high-quality food products. However, their use inevitably leads to a series of side effects on plant production.

Cultural Practices

Cultural control is the manually removing of unwanted pests by using different practices without use of chemicals. Cultural control is considered as an important element for reduction in global climatic impact. Timely hoeing and training of plants are examples of recommended cultural control techniques. Different questions were asked from the respondents to check their awareness level about cultural control.

Table 4: Distribution of respondents according to their awareness regarding Cultural Control

Cultural control	Mean	S.D	WS	RO
Hoeing	2.750	.638	330	1
Training	2.541	.684	305	2
Pruning	2.383	.712	286	3
Removal of diseased plants	2.258	.824	271	4
Weeding	2.216	1.062	266	5

The presented table about awareness regarding different cultural control indicates that among different cultural methods most of the respondents were aware about timely hoeing this response having weighted score 330 and mean value 2.750 and least of the respondents were aware about recommended weeding practices ranked and this response having least weighted score value 266 and mean value 2.216. Similar practices also reported in a study conducted in Ethiopia by Nigussie et al. (2019), according to their findings, common agronomic practices employed by small-scale farmers in apple production include fencing, irrigation, weeding, hoeing, mulching, composting, manuring, training, pruning, and thinning. There are different benefits and outcome of these practices according to the farmers. As stated by Rohan (2006), in a study conducted in Mansehra. They reported that pruning improved annual shoot length, tree girth, fruit set, and yield. Increasing pruning intensity notably enhanced shoot length and fruit set percentage, impacting fruit yield and quality significantly. Farmers discussed the benefits of these cultural practices, noting improved yields and reduced pest attacks due to enhanced plant health. They emphasized that practices like pruning and removing affected parts contribute significantly to healthier plants and increased productivity.

Harvesting Techniques

Harvesting is the process of collecting mature crop from the field. There are different techniques to harvest the plants mechanical picking, net picker and most common harvest method is hand picking (Madalli, 2013). Various questions were asked from apple growers about to probe out their awareness level about different recommended harvesting techniques.

Table 5: Distribution of respondents according to their awareness regarding harvesting techniques

Harvesting	Mean	S.D	WS	RO
Picking by hand	3.016	.987	362	1
Fruit pickers (mechanical picker)	.000	.000	0	2
Picking through net	.000	.000	0	3

The above mentioned table shows that picking by hand was most common harvesting technique in the study area having weighted score 362 and mean value 3.016. The mechanical picker and net picker did not use by growers because unaffordability by the small land holders they cannot afford (as the results regarding age have found that 85.8% respondents were small landholders). Traditional methods of harvesting bears post-harvest losses, there is need to introduce the technology by the government as stated by the farmers as stated by Khan and Bae (2017), technology is surrounded by numerous technical challenges, such as issues with advancements, inefficiencies, outdated techniques, and old machinery. These challenges make it difficult for farmers and other intermediaries to utilize appropriate technologies and methods to minimize pre- and post-harvest waste and operational time. In light of this, there is a need to introduce mechanical picking in the area to ensure high-quality fruit for export, thereby generating substantial income to support the country's economy. The situation was different in the developed countries as they were using the mechanical picking, this picking assist in the maintaining the quality and speed of picking (Wang et al., 2017).

Conclusion

The results of the study depicted that most of the respondents were not aware about the mechanical preparation and they were not using hexagon and triangular system of planting apples plants in field. Among different varieties Red delicious variety was mostly using due to its market demand, while in study are Mashadi and Amri varieties were not being cultivated commonly. Channel or flood irrigation system was mostly used as method for irrigation while most of the respondents were not aware about furrow and drip irrigation method. Most of the respondents were not aware about pre-planation watering of soil and irrigation at 2-3 days' interval to maintain good quality of apple. Perhaps, it was due to water shortage in study area. Traditional fertilizer application methods were using to fertilize the soil (broadcasting and annual splitting) while most of the respondents were not aware about fertigation of fertilizer. Among different spraying methods power tractor spray was most commonly using technique weather as most of the respondents were not aware about Backpack sprayer and compressed air sprayer. Most of the respondents were using howling as cultural method and were less aware about necessity of removing diseased plant form the filed. Manual picking was the most commonly using method for harvesting of mature apples and awareness about mechanical pickers was not existed among the farmers. Among different constrains water unavailability at critical stages, expensive inputs and market problems were most hindering factors in quality apple production.

Recommendations

To support apple growers effectively, policymakers should consider farmers' current awareness levels. The Government of Baluchistan needs to build check dams and restore the Karez system to tackle irrigation challenges and drought conditions. Providing affordable inputs like fertilizers, pesticides, and machinery is crucial. Exempting solar systems from sales taxes and offering subsidies would aid small farmers. Establishing training centers for innovative farming methods is vital. Simplified credit facilities are needed for financially constrained farmers, and direct market access should be facilitated by reducing middlemen. Collaboration with export associations can boost global apple exports. Evaluating extension workers' performance rigorously is essential for effective farmer support.

References

- Adnan, F., Khan, A., Zaib, U., Ahmed, N., Salam, A., & Jatoi, G. H. (2017). Surveillance of apple canker and identification of canker pathogen in apple orchards at district Ziarat (Balochistan). *Pakistan Journal of Biotechnology*, 14(4), 771-775.
- Amir, J. (2003). *An investigation into the adoption of broiler production/management practices by poultry farmers in tehsil Samundri*. M.Sc. (Hons.) thesis, Deptt. Of Agri. Ext. Univ. of Agri., Faisalabad.
- Amiri, M. E., Fallahi, E., & Golchin, A. (2008). Influence of foliar and ground fertilization on yield, fruit quality, and soil, leaf, and fruit mineral nutrients in apple. *Journal of plant nutrition*, 31(3), 515-525.
- An, Q., Li, D., Wu, Y., & Pan, C. (2020). Deposition and distribution of myclobutanil and tebuconazole in a semidwarf apple orchard by hand-held gun and air-assisted sprayer application. *Pest Management Science*, 76(12), 4123-4130.
- Ashraf, M., and R. Shabeer, (2002). Information and communication technology in healthcare management system: prospects for developing. *Int. J. of Com. Application*. 4(2), 122-133.
- Aziz, M., Jadoon, S., & Sh, Z. (2013). Apples pulp (*Pyrus malus*) nutritional profiling evaluation of various varieties of Balochistan. *Pakistan Journal of Nutrition*, 12(3), 239.
- Boyer, J., & Liu, R. H. (2004). Apple phytochemicals and their health benefits. *Nutrition journal*, 3, 1-15.
- Directives, C. (2009). 79/117/EEC and 91/414/EEC. *Official Journal of the European Union*, 24, 1-50.
- Ghulam Murtaza, G. M., & Thapa, G. B. (2017). *Factors affecting technical efficiency of small-scale apple farms in Balochistan Plateau, Pakistan*.
- Government of Baluchistan. (2016). *Provincial Baluchistan Education Sector Plan (BESP)*. Ziarat district profile: 13-14.
- Govt. of Pakistan. (2021). *Fruit vegetables and condiments statistics of Pakistan*. Federal Bureau of Statistics, Government of Pakistan, Islamabad.
- Grove, G. G., Eastwell, K. C., Jones, A. L., & Sutton, T. B. (2003). *Diseases of apple*. In *Apples: botany, production and uses* (pp. 459-488). Wallingford UK: CABI Publishing.
- Hussain, N. (1989). *An investigation into the adoption constraints regarding recommended horticultural practices as perceived by citrus growers of Jaffarabad district of Baluchistan*. M.Sc. (Hons.) Agri. Ext. Thesis. Univ. of Agri. Faisalabad.
- Khan, M., & Bae, J. H. (2017). The environmental perspectives of apple fruit supply Chain management in Chitral, Northern Pakistan. *International Journal of Supply Chain Management*, 6(4), 1-16.
- Khan, N., Ray, R. L., Ihtisham, M., Siddiqui, B. N., Khayyam, M., Anjum, R., & Asongu, S. A. (2022). Socioeconomic Determinants of the Awareness and Adoption of Apple Production Practices: A Case study of Balochistan, Pakistan. *Sarhad Journal of Agriculture*, 38(1).

- Kumar, P., Suman, S., Spehia, R. S., Kumar, V., & Kaith, N. S. (2016). Studies on method and rate of fertilizer application in apple under mulch in north-western Himalayas. *Journal of Plant Nutrition*, 39(2), 219-226.
- Liu, H., & Brouwer, R. (2022). Incentivizing the future adoption of best management practices on agricultural land to protect water resources: The role of past participation and experiences. *Ecological Economics*, 196, 107389.
- Madalli, D. P. (2013, November). *Issues in harvesting resources from agricultural repositories. In Research Conference on Metadata and Semantic Research* (pp. 414-422). Cham: Springer International Publishing.
- Moinina, A., Lahlali, R., MacLean, D., & Boulif, M. (2018). Farmers' knowledge, perception and practices in apple pest management and climate change in the fes-meknes region, Morocco. *Horticulturae*, 4(4), 42.
- Muhammad, A., Ayub, M., Zeb, A., Durrani, Y., Ullah, J., & Afridi, S. U. R. (2011). Physicochemical analysis of apple pulp from Mashaday variety during storage. *Agric. Biol. JN Am*, 2(2), 192-196.
- Murtaza, G.M., Javaid, K and Imran, M. 2003. Factors affecting gross income of small farmers in district Jhang-Pakistan. *Pak. J. Life .Sci.* 2(3), 11-18.
- Nigussie, Z., Fisseha, G., Alemayehu, G., & Abele, S. (2019). Smallholders' apple-based agroforestry systems in the north-western highlands of Ethiopia. *Agroforestry Systems*, 93, 1045-1056.
- Noonari, S., Asif, M., Shah, S. T., Peerzado, M. B., Panhwar, G. M., and Jamro, A. S. (2015). Economic analysis of apple varieties in Quetta District Baluchistan. *Journal of Fisheries & Livestock Production*. 3(3), 68-72.
- Noonari, S., Memon, M. I. N., Wahid, R., Peerzdo, M. B., Bhatti, M. A., & Kalwar, G. Y. (2015). Economic analysis of apple orchards production in district Mastung Baluchistan Pakistan. *Economic Analysis*, 7(10), 2222-2839.
- Rohan, R. S., Khan, M. S., Ahmad Abbas, A. A., Sultan Muhammad, S. M., & Ikhtiar Malook, I. M. (2006). Effect of different intensities of pruning on growth, yield and quality of apple.
- Sadaf, S. (2005). *Need for agricultural extension services for rural women in tehsil Faisalabad*. M.Sc. (Hons.) Thesis, Deptt. Of Agri. Ext. Univ. of Agri., Faisalabad.
- Savci, S. (2012). An agricultural pollutant: chemical fertilizer. *International Journal of Environmental Science and Development*, 3(1), 73.
- Siddiqui, B. N., Muhammad, S., & Ashraf, I. (2007). Awareness of plant protection measures and their adoption by apple growers in Baluchistan. *Pakistan Journal of Agriculture Science*, 44(3), 259-265.
- Siddiqui, B.N., S. Muhammad and N.H. Malik. (2006). Effect of socio-economic aspects on the awareness and adoption of recommended horticultural practices by apple growers in Baluchistan, Pakistan. *Pak. J. Agri. Sci.* 2(1), 43.
- Travis, J. W., Skroch, W. A., & Sutton, T. B. (1987). *Effect of canopy density on pesticide deposition and distribution in apple trees*.
- Wang, D., Song, H., & He, D. (2017). Research advance on vision system of apple picking robot. *Transactions of the Chinese Society of Agricultural Engineering*, 33(10), 59-69.