Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 07:2022
DOI10.17605/OSF.IO/2ZCJG

FACTORS INFLUENCING APPLE (MALUS DOMESTICA) PRODUCTIVITY IN DISTRICT MASTUNG, BALOCHISTAN, PAKISTAN

BASHIR AHMED[1], GHULAM MURTAZA[2*], MUHAMMAD ASHRAF[3], SYED AINUDDIN[4], JAMAL-UD-DIN[5] and ABDUL RAHIM[6]

[1]Ph.D. Scholar, Department of Disaster Management and Development Studies, University of Balochistan, Quetta, Pakistan.
[2]Department of Disaster Management and Development Studies, University of Balochistan, Quetta, Pakistan.
[3,4,5,6] Department of Disaster Management and Development Studies, University of Balochistan, Quetta, Pakistan
*Corresponding author Email: gmurtaza_80@yahoo.com

Abstract:

Agriculture is a prime source of livelihood for more than 2.5 billion population, in particular, residents of rural areas in developing countries. Agriculture is a mainstay of economy and immensely contributes to GDP of many developing countries. Apple (Malus Domestica) alone is responsible for world's 50 per cent of deciduous cash crop tree production. Balochistan is the leading apple producing province of Pakistan contributing about 576,400 tones (88.78 per cent) of apple in 2019-20. This paper identifies contributing factors to apple productivity in district Mastung, Balochistan. Multiple-Regression-Model (MRM) and Correlation coefficient were used to check predictability in the outcome variable and independent variables. The MRMindicated58 per cent variation in the model was explained by all the predictors for the outcome variable (Apple Yield).The study affirmed that agriculture productivity is not only influenced by physical capital, but also by human capital. Findings revealed that farming experience, family labor, tree density, access to credit, extension services and trainings, and irrigation constraints significantly affect apple productivity. With a continuous growing population and depleting water resources in the province, the process of integrated water resource management is highly recommended, thereby increasing the economic and social welfare development without upsetting the ecosystem. The approach is also essential to mitigate the impact of seasonal and cyclical droughts.

Keywords: Apple, yield, productivity, irrigation constraints, Balochistan

1. INTRODUCTION

Agriculture been the prime source of livelihood for 2.5 billion residents of rural areas across the globe in developing countries (Shiferaw et al., 2014; Keshavarz et al., 2017). In most of developing countries agriculture is a mainstay of economy and immensely contributes to their annual GDP (Keshavarz et al., 2014). The vast majority of small-scale rural farmers in developing countries is mainly dependent on rain-fed agriculture for their ends meet and occasionally afflicted by some climatic and weather vagaries. Among important climatic events, variability in rainfall accounts for serious impacts on livelihood of small-scale poor farmer and on the economies of most of developing states (Meemken & Bellemare, 2020). For millions residents of under-developed countries and poor families, climate unpredictability and variability pose an inevitable risk that can potentially limit options and restrict their development and remain a major challenge (Dietz et al.,

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 07:2022
DOI10.17605/OSF.IO/2ZCJG

2020). Additionally, the persisting consecutive drought spells in Balochistan province have added to water depended population's vulnerability to intense level (Shah & Yousuf, 2018). The ongoing exploitation of water resources i.e. ground water in Balochistan is the result of successive spells of drought in the province. Despite the availability of two potential basins in Balochistan (The PishinLora[1] and Nari), there is higher exploitation of ground water. The rise in water drafting from the two basins is menacing in long term leading to drying up the aquifers (Latif et al., 2016).

Balochistan, among other provinces of Pakistan, is the most stressed region in context of drought. Its larger populace resides in the rural areas and 85% of the families depend on livestock and agriculture for their income (Ashraf & Routray, 2013). The province's provincial economy depends too mainly on livestock and agriculture sectors that encompass 67% of labor force (Ashraf & Routray, 2013). However, productivity in terms of agriculture has been defined as the capability of a unit of inputs to produce a particular level of outputs. Agriculture outputs show how a certain farmer is in the utilization of specific inputs provided a range of alternative technologies availability. Agriculture's partial productivity measure can be obtained by dividing the whole physical products by the use of given inputs. Accordingly, production of land is the yields per unit of the given farm size and productivity of labour is the mean outputs per unit of the labour administered. In testing the association between the productivity and farm size, production of land has been taken as the most appropriate measure of productivity in the most works. However, inverse association between the land production and functional land size holding prevails in some regions. The first negative association between land productivity and farm size was observed in Russia by Chayanov (1966). According to Sen (1962) in India the small sized farms are comparatively productive because the operators of small scale farms are able to apply more inputs in terms of labour and hence the output is obtained in larger size. The amount of family operators goes remarkably up when the size of land falls (Wickramaarachchi & Weerahewa, 2018).

2. LITERATURE REVIEW

Apple alone is responsible for world's 50 per cent of deciduous cash crop tree production (Ntakyo et al., 2013). Among the apple growing countries, China is the leading country with about 41 per cent of world's apple production; followed by United States of America, Turkey and India. However, in case of Mastung people are greatly dependent on farming and raring of animals and private and government jobs. The prominent crops are wheat, barley, cumin, vegetables, fodder and sunflower in the Rabi season and Mung-beans, fruits, onion, potato, vegetables, melons, chillies, fodder, coriander and garlic in the Kharifseason. Fruits include almond, apple, apricot, grapes, peach, plum, pear and pomegranate (IUCN, 2011). Further, recurring climatic changes is the main challenge in the province. Therefore, assessment of climate is necessary protective processes which can be taken to avoid the huge losses. Moreover, Balochistan is believed as one of the leading apples producing provinces in the country, Pakistan, which accounts for about 92 per cent area under apple cultivation and 83 per cent for total production in 2011 and 12.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 07:2022
DOI10.17605/OSF.IO/2ZCJG

By the time, due to the virtue of suitable soil condition and favourable temperate climatic conditions, apples of various quality produced was well known for their unmatched tastes and unique quality (Murtaza & Thapa, 2015). The province Balochistan not only ensures provision of production to other provinces of the country but also supplies a major production to other countries. In the fiscal years 2020-21 the total apple production was 576,400 (about 89%) tons of which 83.1 per cent was contributed by Balochistan. But, of the total production in the country, a tiny portion (1573 tons) which worth about $477,000 (forty million Pakistani rupees) were exported to other countries (GoP, 2020). The volume of total exported production accounted for less than one per cent. For several decades farmers in Balochistan have been engaged in the production of apples as they see it a good economic benefit from apple production enterprise (Murtaza & Thapa, 2017).

Balochistan is one of the most insubstantial provinces of Pakistan. The water shortage is most severe problem in the province today. Most of the areas in Balochistan are in arid zone with very low annual rainfalls. The economy of province depends upon agriculture therefore the water shortage is an existential danger. The main reason of decline in agriculture productivity is due to not receiving enough water by farm lands. The province constitutes about 89 per cent of apple production of Pakistan. There are diverse climatic regions in Balochistan; arid to semi- to hyper-arid and from cool temperate to hot temperature. There are four climatic regions in the province namely, plains, desert, uplands and coastal, (PARC, 1980). Furthermore, agriculture is a mainstay for Balochistan's development and its people for last forty years, and it has heavily been driven by a dramatic increase in proliferation of tube-well services and canal command areas. Balochistan's agriculture including livestock, shares one-third to provincial GDP with two-thirds labour force employment, and ensures livelihood provision to more than its half the population. Almost one in two households in the rural is headed by agricultural labourer or a crop farmer, thus production of crop is indispensible to encountering poverty and raising incomes of rural households (Rana et al., 2021).

On the other hand, the effects of global climate change on water resources, including changes in glacial melt, temperature, and precipitation patterns lead to variations (often negative) of river flows and increased instances of floods and droughts. Analysts projected that all rainfall/snow-fed rivers will have a significantly reduced discharge in the long-run. Glacier-fed rivers will increase their discharges by 10-15 percent through 2050 but thereafter also significantly reduce their discharges. A 2008 report of the International Board on Weather Change report forecasts that climate change over the next period will upset patterns of rainfall, streams and sea stages all around the world. About 20 percent decrease is expected in different arid areas. Changing climate is responsible for declining rainfall in most parts of the world, and temperature increases will suggest greater loss. Climate models plan declining precipitation in arid areas, such as the Balochistan, Middle East Middle East and Africa. Earlier snow melt in south Asia, and the loss of glacial buffering in the Karakorum - Himalayas will disturb the seasonal water supply of the Asia. Underground water use has become unsustainable. In many areas of the Pakistan, mostly in Baluchistan, aquifer drawdown cannot be placed on this resource. Other

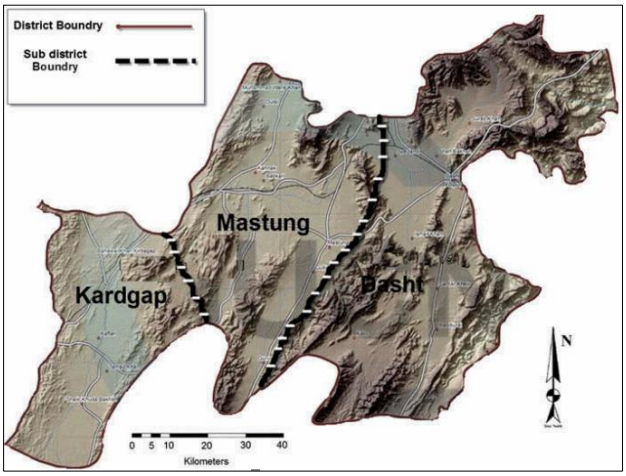
Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 07:2022
DOI10.17605/OSF.IO/2ZCJG

impacts of changing climate on water sources include threat to agriculture and food security especially in arid and semiarid areas, decrease in hydropower generation in many developing countries, placing stress on the energy infrastructure, and increased risk to ecosystems, particularly forests and wetlands and increase vulnerability of coastal areas.

3. MATERIAL AND METHOD

3.1.1. Study Area Profile

The study was held in district Mastung, one of the most drought stressed districts, in the north of Balochistan (Figure 1),Geographically, the land covered area of the district is 5,896 km^2 and it lays between 66°11'34"-67°25'59" East Longitudes and 29°20'13"-30°15'8" North Latitudes, there are four Tehsils[2] and 13 UCs in the district. The weather is arid hot during summers and mild to cool in winters. There are minimum rainfalls during winter seasons. The population is 164,645. There are 20,447 housing units in the district and 8 persons per household on average (IUCN, 2017).About two third of the population in the study area depends on farming activities and cattle grazing in the rural. Typically, the district has two means of irrigation system. Firstly, its irrigation relies on seasonal run-offs, which is known as Sailaba in local language; and secondly, on groundwater which includes open surface wells, tube-wells, springs and Kareze systems. The data was collected from four Tehsils which included some personal information such as demographic details, dependent population and household heads. District Mastung is also a male dominated region as other districts of the province. Therefore, data was collected only from male respondents who happen to be the heads of households too.



3.2. Multiple Regression Analysis

Multiple regression analysis was carried out in order to know factors contributing to apple yield in the study area. And correlation matrix was performed to ascertain the independent

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 07:2022
DOI10.17605/OSF.IO/2ZCJG

variables association dependent variable and to one another. Yield function is prognosticated on per acre of land.

The equation (1) shows multiple regression models as follows;

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \epsilon$$

The dependent and independent variables are as follows:

Table 1: Apple Farmers' Profile

S.NO	Variables	Description	Average	Standard Deviation
1	Apple Yield	Apple Production Per Acre in the Study Area	105.65	64.6
2	Literacy (Dummy)	Farmer's Education (1 = Educated ; 0 = Illiterate)	0.62	---
3	Farming Experience	No. of Years Involved in Farming	19.63	10.21
4	Agriculture Labor	No. of HH members aged 14-60 involved in Agriculture	3.31	1.9
5	TW Operating Hours	No. of Solar Tube-Wells Hours Operates in a Day	7.59	9.35
6	TW Service Area	Landholding Size Under Tube-Well Service in Acre	11.97	8.31
7	Apple Tree Density	No. of Trees per Acre	102.95	113.276
8	Paved Channels	1= If the orchards have Paved Channels, 0= otherwise	0.36	0.48
9	Credit Access	1= Farmers Having Access to Credit, 0= otherwise	0.33	0.47
10	Extension Service Officer (Dummy)	1= Farmer accessed Extension Service, 0= otherwise	0.37	0.48
11	Training	1= Farmer Receiving Training, 0= otherwise	0.22	0.41

4. RESULTS AND DISCUSSION

4.1.1. Respondents' Profile

Respondents were surveyed from four Tehsils of district Mastung. In which there were 90 villages and 13 union councils, out of those44.3% were from Mastung Tehsil, 19.7% were from Dasht, 26.1% were from Khad Kucha and 9.8% were from Kirdigab. All the interviewed respondents were male due to strict tribal culture. The educational level of the respondent farmers varied from illiterate (little more than one-third) to university

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 07:2022
DOI10.17605/OSF.IO/2ZCJG

degree(13.3%). while, 17.0% of the individuals were primary school qualified, 16.3% had secondary education, 18.6% had passed out after their intermediate and. Average Age of the respondents was almost 50 years ranging from 26 to 83 years.

In the field the dependent members of the households above 60 was 413 individual with minimum number of 1 and maximum 10 besides above 60 those less than 14 years of old were 1484 with minimum number of 1 and maximum 25 members in a household. However, the total number of surveyed households between 14 years of old to 60 years of old fell to 2109 with 2 members minimum and 20 maximum members.

The table (1) shows households' land farming profile. It is revealed that the average apple production per acre in the study area is 105.65 crates[3]. When it comes to farmers' literacy, about one-third of the farmers never attended any formal education. And those either with attending primary school or higher were all regarded as educated which was two-thirds. Farmers' agriculture experience noticeably varied among them. The average farming experience was 19.63 years. Almost all respondent farmers reported having the use of flood irrigation mode and while just only 1.1 per cent of the farmers had adopted drip irrigation system for their farming. Average number of family member involved in farming activity was 3. The average tube-well service area was reported 11.97 acre. The average number of apple trees per acre was reported 102.95 trees. However, apple trees quantity varied due to farming priority of the farmers. For instance, many farmers had less apple trees but their inclination was more towards other fruit trees e.g. Peach, Black Hamber etc. Besides these, almost half of the farmers documented that they never paid visit to any extension officer nor any extension officer ever paid visit to their farmlands. And the same condition was noticed in the case of getting training. Only a tiny percentage of farmers (22%) had attended training.

Table 2: Factors of Apple Productivity by Multiple Regression Model

Variables	Coefficients	Statistics-T-Values	Probability
Constant	---	4.611	0.000
Literacy	-5.498	-.711	0.478
Farming Experience	1.037	2.609	0.010**
Family Labor	0.020	3.418	0.001***
Tube well Operating Hours	0.080	0.214	0.831
Tube Well Service Area	-1.902	-2.719	0.007***
Tree Density	-0.114	-2.537	0.012**
Paved Channels	-7.190	-0.910	0.364
Credit Access	23.947	2.846	0.005***
Extension	27.714	3.611	0.000***
Training	30.620	3.277	0.001***
R-Square	0.586	---	0.000***

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 07:2022
DOI10.17605/OSF.IO/2ZCJG

F-Value	13.076	---	0.000***
(*), (**), (***) Show significance level at 10%;5%;and 1% respectively.			

4.2 Factors of Apple Productivity

The results in table (2) reveal that coefficient of determination of the Multiple Regression Model (MRM)is 0.586with $p < 0.01$indicates that total 58 per cent variation in the model is explained by the all the predictors for the outcome variable (Apple Yield). And the F-value 13.076 with $p < 0.01$ indicates that all the independent variables have significant contribution to apple yield in the study area. However, the model shows predictability of each independent variable respectively. In the model four predictors are found having negative effect on apples' production.

The coefficients associated with farmers' farming experience β_i= 1.037, ($P < 0.01$)indicates that if the farming experience increases by one year, there will be an increase of 1.037 kg in the apple yield per tree. As discussed by (Šūmane et al., 2018)that the most essential aspect of farmers' experience is that, the farmers' experience is directly tied to their actions which means it is not only farmers mental capability but also carries components of physical and practical skills. In connection to this, it is obvious that farmers' knowledge can be observed to arise from their engagement in the experimental or regular practices. Over the course of time, the farmers gradually monitor and evaluate effects of their decisions and practices. Therefore, the adjustments that farmers make actually never come to an end because they constantly advance to other adjustments in the other domains of farming. This process revolves; farmers adjust repeatedly, monitor and evaluate the effect and adjust again. Each time, the farmers discover that they lack knowledge, and on the other hand, they are aware of the situation that they have to deal with it based on their available knowledge. In this way, the farmers learn by practicing or doing and do through learning. And the study held by Murtaza & Thapa, (2015)had gotten the same results that apple yield increases with farmers' farming experience because over the course of time, the farmers utilize their trial-and-error method via which they accumulate particle knowledge and ultimately make proper control of pests, land fertilization and orchard management.

The coefficients associated with deploying of family labors β= 0.020, ($P < 0.01$)indicates that by inducting one more family labor in the field will significantly lead to an increase of 0.02 kg in apple yield. As found by (Chowdhury, 2016) in his study conducted in Bangladesh that by employing family labor in agriculture results in higher yield than employing waged labors because they put more efforts while taking care of trees and other plants than those hired. Moreover, family labors provide higher quality and are self-supervised and comparatively more motivated than waged labors. But in the case of tube-well service area, the associated coefficient β_i= -1.902, ($P < 0.01$)indicates that if tube well service area decreases by one unit, there will be 1.902 kg increase in the apple yield.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 07:2022
DOI10.17605/OSF.IO/2ZCJG

Such as discussed by Namara et al.(2010) that in many a developing country, water is a vital factor constraining yield of agriculture.

Similarly the coefficients associated to Tree Density isβ_i= -0.114, (P < 0.05) indicates that if tree density increase by one unit, there will be decline of 0.114 kg in the apple yield. A similar study was conducted by in the Po Valley of Italy, the results of the study revealed that increasing tree density results in two things: high yield per tree and hectare and higher fruit size and quality. But lower yield was also witnessed as soon as the land received highest trees planting density which critically not only reduced fruit size but it also affected quality. One of the possible reasons for quality fruit yield is that the trees planted at higher densities grow taller than those with lower densities(Bhusal et al., 2017). The correlation matrix (Appendix 1) shows significant positive correlation between apple yield and tree density.

The coefficients associated with farmers access to creditβ_i=23.947, (P < 0.01) indicates that farmers that have credit access leads to an addition of 23.94 kg per tree in the apple yield. Similar results were obtained by Murtaza & Thapa, (2015) that apple yield was comparatively lower of the farmers without access to credit than those had access to credit. Because formal credit availability is likely to accelerate farmer's adaptation to new technologies, enhance market efficiency and leads to lessening of informal sources of credits, thus improves smallholders' income via rise in production. Unavailability of formal credit has been found one of the crucial factors determining performance of farms by limiting inputs and access to information in both economies: developing and developed. Concerning the substantial positive impact of credit availability in enhancing technical aspect efficiency, as farmers have access to agriculture credit will let them have access input on time, safeguard against burnout of tube-wells, adopt new machineries required for agriculture yield efficiency and improve irrigation patterns. Further, coefficients associated with the extension services β_i= 27.714, t = 3.611 with P < 0.01indicates that farmers that receive extension services comparatively have an increase of 27.7 kg per tree in the apply yield. As in other districts under their provincial jurisdiction, the Balochistan government has also extended agricultural assistance in the Mastung region. The regional agricultural aid organization structure has 138 staff members including Agriculture officials and subject specialists at the regional offices, as well as extension staff at union council levels. The main purpose of the department of Agricultural extension is to improve agricultural production by advising farmers on land reforms, irrigation methods, and pest control through training, visits and awareness campaigns. The Agricultural Research Institute Quetta (ARI), which provided information to the first author about the production of apples on its experimental farms, is located about 25 km north of the district Mastung.

While in the case of training, the coefficients associated with farmers receiving trainings β_i= 30.620, t = 3.277 with P < 0.01indicates that farmers that had received trainings on behalf of agriculture department or by different NGOs comparatively have an increase of 30.62 kg per tree in the apply yield. As founded by Murtaza & Thapa, (2015) that farmers

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 07:2022
DOI10.17605/OSF.IO/2ZCJG

participating in agriculture related training programs had moretechnological knowledge and resultantly contributed significantly to apple yield. Furthermore, in appendix (1) the table presents results of correlation matrix on Spearman and Pearson correlation coefficient tests respectively. And it shows a positive association between farmers' training and apply yield indicating that farmers with more training do have higher apple yield than those with training. However, amongst the dependent and independent variables there was found both positive as well as negative correlation between a predictor and outcome variables statistically significant at 0.05 and 0.01 levels.

5. CONCLUSION AND RECOMMENDATION

This paper mainly aimed at identifying factors contributing to apple productivity in the Mastung district of Balochistan plateau, Pakistan, and then analysing them via multiple regression model so as to find their statistically significant contribution to the apple yield. This particular study also took into account the tube-well service area and tube-well operating hours. Traditionally, the agriculture productivity is being explained by some of the aforementioned factors and literally by land quality, land quantity, inputs such as fertilizers, seeds quality, irrigation method, wealth condition, machinery employed and etc. However, these factors happen to explain a fraction of variance. But this concerned study as well as previous studies revealed that agriculture productivity is not only influenced by physical capital, but also by human capital – literature showed that the education level of the labour force inducted in agriculture. The labours' education is significantly influencing agriculture practices such as use of modern inputs, machinery, irrigation, selection of crop and fertilizers. Moreover, Scarcity of water in Balochistan and the issues highlighted in this study's literature will be exacerbated by population growth, increasing urbanization, mining, and industrialization in the future. With a population growth rate of close to 3 percent, by 2025 the total population of Balochistan will increase by 50 percent and the urban population will double. In this case, the process of integrated water resources management is highly recommended. The principle of integrated water resources management (IWRM) is the process of helps in coordination and water management and other linked sources, for increasing the economic and social welfare development without upsetting the ecosystem. The approach is also essential to mitigate the impact of seasonal and cyclical droughts and IWRM Policy Implementation. Implementation of IWRM is a gradual long term process that can only be fully achieved over a couple of decades. Implementation will be carried out in steps, which will be supported and spearheaded through this Project. Component A and its sub-components would be the first step towards enhancing the broader institutional capacity of the province within which IWRM would be implemented. An extension campaign is to be launched to get the farmers to produce high quality apple for export and farmers must be given a proper training about proper management of orchard practices (utilization of compost manure, green manure, pesticides, chemical fertilizers and irrigation) by enhancing extension services.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 07:2022
DOI10.17605/OSF.IO/2ZCJG

References

Ashraf, M., & Routray, J. K. (2013). Perception and understanding of drought and coping strategies of farming households in north-west Balochistan. International Journal of Disaster Risk Reduction, 5, 49–60. https://doi.org/http://dx.doi.org/10.1016/j.ijdrr.2013.05.002

Bhusal, N., Han, S. G., & Yoon, T. M. (2017). Summer pruning and reflective film enhance fruit quality in excessively tall spindle apple trees. Horticulture Environment and Biotechnology, 58(6). https://doi.org/10.1007/s13580-017-0375-y

Chayanov, A. V. (1966). Chayanov_1966.pdf. In The American economic association translation series.

Chowdhury, N. T. (2016). The Relative Efficiency of Hired and Family Labour in Bangladesh Agriculture. Journal of International Development, 28(7). https://doi.org/10.1002/jid.2919

Dietz, T., Shwom, R. L., & Whitley, C. T. (2020). Climate change and society. In Annual Review of Sociology (Vol. 46). https://doi.org/10.1146/annurev-soc-121919-054614

GoP. (2020). Agricultural Statistics of Pakistan.

Keshavarz, M., Karami, E., & Zibaei, M. (2014). Adaptation of Iranian farmers to climate variability and change. Regional Environmental Change, 14(3). https://doi.org/10.1007/s10113-013-0558-8

Keshavarz, M., Maleksaeidi, H., & Karami, E. (2017). Livelihood vulnerability to drought: A case of rural Iran. International Journal of Disaster Risk Reduction, 21. https://doi.org/10.1016/j.ijdrr.2016.12.012

Latif, M., Haider, S. S., & Rashid, M. U. (2016). Adoption of high efficiency irrigation systems to overcome scarcity of irrigation water in Pakistan. Proceedings of the Pakistan Academy of Sciences: Part B, 53(4B).

Meemken, E. M., & Bellemare, M. F. (2020). Smallholder farmers and contract farming in developing countries. Proceedings of the National Academy of Sciences of the United States of America, 117(1), 259–264. https://doi.org/10.1073/pnas.1909501116

Murtaza, G., & Thapa, G. B. (2015). Determinants of Yield Gap in Small-scale Apple Farms in Balochistan Pakistan Determinants of Yield Gap in Small-scale Apple Farms in Balochistan , Pakistan. Journal of Crop Improvement, 29(2), 196–227. https://doi.org/10.1080/15427528.2014.994054

Murtaza, G., & Thapa, G. B. (2017). Factors affecting technical efficiency of small-scale apple farms in Balochistan Plateau, Pakistan. Journal of Mountain Science, 14(4), 782–794. https://doi.org/10.1007/s11629-016-3937-z

Namara, R. E., Hanjra, M. A., Castillo, G. E., Ravnborg, H. M., Smith, L., & Van Koppen, B. (2010). Agricultural water management and poverty linkages. Agricultural Water Management, 97(4), 520–527. https://doi.org/10.1016/j.agwat.2009.05.007

Ntakyo, P. R., Mugisha, J., Elepu, G., & Economics, N. R. (2013). Socio-economic factors affecting apple production in South-western Uganda. African Crop Science Journal, 21(4), 311–321.

Rana, A. W., Moeen, M. S., Shikoh, S. H., & Davies, S. (2021). Proposed Balochistan Agriculture Policy 2021. April.

Tianjin Daxue Xuebao (Ziran Kexue yu Gongcheng Jishu Ban)/
Journal of Tianjin University Science and Technology
ISSN (Online):0493-2137
E-Publication: Online Open Access
Vol: 55 Issue: 07:2022
DOI10.17605/OSF.IO/2ZCJG

Sen, J. (1962). The Indian Botanic Garden, Sibpur, Calcutta. Nature, 195(4836). https://doi.org/10.1038/195018a0

Shah, S., & Yousuf, M. (2018). Livelihhod Vulnerability to Drought and its Impacts on Socio-Economic Conditions of Farming Families in District Nushki : Balochistan. 175–190.

Shiferaw, B., Tesfaye, K., Kassie, M., Abate, T., Prasanna, B. M., & Menkir, A. (2014). Managing vulnerability to drought and enhancing livelihood resilience in sub-Saharan Africa: Technological, institutional and policy options. Weather and Climate Extremes, 3. https://doi.org/10.1016/j.wace.2014.04.004

Šūmane, S., Kunda, I., Knickel, K., Strauss, A., Tisenkopfs, T., Rios, I. des I., Rivera, M., Chebach, T., & Ashkenazy, A. (2018). Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture. Journal of Rural Studies, 59. https://doi.org/10.1016/j.jrurstud.2017.01.020

Wickramaarachchi, N. C., & Weerahewa, J. (2018). Relationship between Land Size and Productivity : Empirical Evidence from Paddy Farms in Irrigation Settlements of Sri Lanka. April 2019.

Appendix A.1: Correlation Matrix

		1	2	3	4	5	6	7	8	9	10	11
1	Apple yield	1										
2	Literacy†	0.09	1									
3	Farming Experience‡	0.34**	-0.05	1								
4	Family Labor‡	0.32**	-0.18**	0.30**	1							
5	Tube well operating hours‡	-0.06	-0.04	0	0.01	1						
6	TW Service Area‡	-0.30**	-0.02	-0.09	-0.09	0.16**	1					
7	Tree Density‡	-0.15*	0.23**	-0.11	-0.21**	-0.04	-0.21**	1				
8	paved channels†	-0.08	0.21**	-0.11	-0.14*	-0.1	-0.20**	0.27**	1			
9	Credit Access†	0.57**	0	0.21**	0.25**	-0.04	-0.23**	-0.02	-0.1	1		
10	Extension†	0.17**	0.14*	0.12*	0.12*	-0.08	-0.23**	0.18*	0.20**	0.04	1	
11	Training†	0.41**	0.23**	0.1	0.17**	-0.07	-0.12	0.02	0.08	0.39**	0.11	1

* and ** indicate correlation is significant at 0.05 and 0.01 level.

† and ‡ indicate Spearman and Pearson correlation coefficient, respectively.