Agricultural Productivity Impact of a Mini-Dam: A Case Study of Ziarat, Baluchistan

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ABSTRACT

Water scarcity in Baluchistan is more severe as of Pakistan. Ground water level is depleting day by day. One of the solutions for such problem is to store water through mini dams. This study is conducted to find an impact of mini dam on agricultural productivity in Ziarat, taking apple as the main crop. Primary data of 80 households are collected from two villages (one having a dam and other without having a dam) namely Kawas and Verchoom through stratified random sampling. Cobb-Douglas production function is utilized to form the production function for apple and estimated by using OLS technique. Eight explanatory variables are used for finding the impact over apple yield i.e. farm size, farmer education, farming experience, tree age, fertilizer, irrigation number, pruning & dummy (for capturing the importance of dam). Results revealed that all variables are found significant except farming experience and tree age. It is concluded that mini dam played an important role in increasing agricultural productivity, livelihood of the community and contribute in improving their living standard.

Key words: Mini-dam, Agricultural productivity, Stratified random sampling, Cobb-Douglas production function, Ordinary Least Squares (OLS) technique

INTRODUCTION

Water is the most important constituent of life without which, life cannot exist. Water is a natural resource which is also used as an input for producing different goods in factories for industrial use etc. Despite such an importance, still the World is experiencing the issue of water scarcity (WCD, 2000). The supply of water does not meet its demand (Bengali, 2009). Pakistan is an agrarian economy which is also heavily dependent on water. About 45% of the total

employment is generated from Agriculture sector (GoP, 2011). Main sources of water are rivers and rainfall.

Baluchistan is the largest province of Pakistan. Land size is 44% of the total land of Pakistan (GoB, 2010). Land is fertile and provides conducive environment for Agriculture. Agriculture productivity is high in Baluchistan. Many vegetables and crops are grown which results in many farmers and labors livelihood. It has got varieties of species of many fruits, particularly Apple. Important fruit crops grown are apple, grapes, cherry and peach. Climate is also suitable for crops growth particularly the deciduous fruits like apple, which requireslow temperature during summer season. As far as quality is concerned, apple produced in Baluchistan, especially at high altitude (1600 meters to 2000 meters) are superior in quality than that produced in the rest of the country. The main reason is that due to dryness of the climate in apple producing areas like Ziarat, Killa Abdullah, Pishin, Quetta etc. Apple is one of the most popular fruit. It is delicious and crunchy and is mostly liked by health conscious and fitness lovers as it is filled with rich phyto-nutrients, which is very essential for optimal health. It also contains antioxidants, which promotes health as well as prevents several diseases. Thus, apple truly justifies the famous sayings, "An apple a day keeps the doctor away." One of the distinguishing features is that there are no fungal diseases and disease free apple can be stored for a longer period in cold storage. Also the abundance of sunshine in the growing season improves the color of apple which fetches a good price in the domestic and foreign market.

Baluchistan, being located far from Indus River, experiences water scarcity more than other provinces of Pakistan (Bengali, 2009). Main source of water is rainfall but, last two decades shows a downward trend on the water table due to lack of rainfalls (Shah *et al*. 2002). Both surface and ground water level is deteriorating day by day (GoB, 2010). Due to this situation, farmer's conscious to save trees and grow crops with such water scarcity condition is out of question.Water scarcity is the major constraint behind the lack of its productive capacity. Most of the natives of this district are dependent solely over agriculture. The basic purpose of dams is to store water in wet times and provide water in dry times (WCD, 2000).It also helps in ground water recharge near the open surface wells particularly in Baluchistan. The mini dam selected for this study is Kawastangi storage dam. It is located in village Kawas at district Ziarat, Baluchistan. Its distance is 90 km from Quetta city. Its catchment area is 27.4 sq. km,

storage capacity is 2463309 m^3 and height is 29.87 m (Cameos *et al.* 2008). No study has yet shown the impact of mini-dam on the agricultural productivity, particularly apple. This study shows apple production function using mini dam indicated by dummy variable which not only increases apple productivity, but, it also improves quality, taste, size as well as reduction in the cost of irrigation as dam water is free of cost.

Many studies have been conducted regarding agricultural productivity for several crops. Bathan and Lantican (2010) found that the amount of fertilizer and adequate labor significantly improved banana yield. On the other hand, farming experience and education resulted in the decline in banana yield.Ahmad *et al.* (2005) determined factors affecting carrot yield. Study showed that sowing along with higher amounts of seed and fertilizer significantly improved carrot yield, while high inputprices, limited capital and insufficient labor were found to be insignificant. Baksh*et al.* (2004) studied the determinants of cauliflower yield and revealed that years of farmingexperience and education, household size, use of farmyard manure and inorganic fertilizer, andnumber of irrigation systems positively influenced cauliflower yield.

METHODOLOGY

Basic objectiveofthis paper is to find the significance of mini dam on the agricultural productivity, specifically on the production of apple in Baluchistan.The study reveals the estimation of an econometric model for apple production function. Primary data is collected by a pre-tested questionnaire from eighty apple growers, forty from each village. Therefore, the data for this analysis is cross sectional regarding apple yield as an output against eight explanatory variables included as inputs of production and grower. So far no study has been conducted in Baluchistan which identifies the explanatory variables that affect the apple yield using dam water as the main source of irrigation, therefore, the study used multiple regression model of the Cobb-Douglas production functional form (Baksh*et al.* 2004; Ahmad *et al.* 2005; Bathan&Lantican, 2010) for estimating apple yield using Ordinary Least Squares (OLS) technique. Detail regarding the model is explained below.

Model for Apple Production Function

The yield response model for the sample apple growers considered nine explanatory variables including inputs of production and grower, and specifying importance of a mini dam is given as:

$$\ln AY_i = \beta_0 + \beta_1 \ln LS_i + \beta_2 \ln FEX_i + \beta_3 \ln FED_i + \beta_4 \ln PA_i + \beta_5 \ln FER_i + \beta_6 \ln IRR_i + \beta_7 \ln PRU_i + \beta_8 \ln P_i + \beta_9 \ln D_i + e_i$$

where: ln = natural logarithm;
AY = apple yield (crates/ acre);
LS = land size (acre);
FEX = years of farming experience;
FED = farmer education (formal education);
PA = age of plant/ tree (per acre);
FER = fertilizer (kg/acre);
IRR = irrigation number;
PRU = pruning (per acre);
P = pesticides (liters/ acre);
D = dummy (1 if dam, 0 if no dam);
β_0 = intercept;
β_i = regression coefficients; and
e = error term.

Where AY stands for Apple Yield, which is a dependent variable. Following are the independent variables with justification and expected sign:

Dummy variable is included in the model to show the difference between the two villages selected for the study. It is the most important variable as this determines the impact of mini dam. One village refers to farm having a dam, while other village has no dam. Two villages are selected especially for this purpose. The village having dam pays less on irrigation and thus, earn higher profit as compared with other village which is having no dam facility. Kawas village should have higher production as compared with Verchoom village. Thus, expected sign of dummy variable is also positive. No such study is conducted for production function using a dummy variable for highlighting mini dam influence on the crops for different regions within same district.

LS is the cultivated area/ farm where Apple trees are grown. It is an important independent variable because the larger the farm size, the more will be the production and vice versa. Studies showed inverse relationship between them (e.g. Kiani, 2008; Ahmad &Qureshi, 1999). Expected sign of land size is positive for this study by assuming that increase in size of the farm would increase apple productivity.

As far as FEX is concerned, it is calculated from farmers' that part of age, after becomes 18 years old. Difference between 18 years and the present age of farmer will give farming experience. It also plays an important role in the production process because the more the farmer is experienced, more will be the production of Apple and vice versa. Expected sign of this variable is also positive. Several studies have been conducted regarding production function in Punjab who had taken into account farming experience as an explanatory variable (Ahmad *et al.* 2005; Baksh*et al.* 2004).

FED is calculated in number of schooling years passed. It gives farmers technical knowledge and know how in maximize their output, revenue and to move towards innovations for producing better variety and quality of Apple, so that it may be sold at a high price and yield more profit. Thus, its expected sign is also positive. Studies also used education as an explanatory variable regarding their production function to see how much influence will that have on their yield (Bathan&Lantican, 2010; Ahmad *et al.* 2005; Baksh*et al.* 2004).

Age of plant/ tree also matters in the production of Apple. The size of the trees is not so large, but, with its age, it starts producing large quantity of Apple as compared to the time when it was small. The stems and leaves of this tree expand and cover more area and therefore, should produce more output. Hence, it should also increase the production of apple. So the expected sign of this variable is also positive. Study showed that more than 50% farmers in Ziarat district had planted apple trees only for generating high returns/ income (Khair*et al.* 2002).

Several fertilizers are used in Apple production by farmers in both villages. It varies from farmer to farmer according to their land size, number of trees grown and their affordability. The expected sign of this variable is positive. That is why it is also an important variable in the production process. It provides nutrients to the plants which helps them grow faster and of good

quality. Studies also used fertilizer as an explanatory variable and considered it as most important input used in the process of production of crops (Bathan&Lantican, 2010; Ahmad *et al.* 2005; Baksh*et al.* 2004).

Irrigation number is calculated by number of times farm is irrigated by the farmer. It is the most important variable especially for Apple production function. It not only provides water to the crop as its input, but, is also plays a crucial role in determining their profit as it is most expensive input as compared with others. Other studies also added irrigation number as explanatory variable for finding its impact over the productivity (Ahmad *et al.* 2005; Baksh*et al.* 2004). Recommended irrigation for apple trees is 10 days for small trees while 15 days for large trees (Baloch&Achakzai, undated; Raja &Baloch, undated). Despite the fact, growers in the study area irrigate after 18 to 20 days in Verchoom to avoid cost, while Kawas irrigate after 17 days as it has dam water which increases the irrigation duration and lasts long in the soil.

PRU is a process of cutting and setting trees by making them strong and healthy, to provide maximum sunlight and air to the crops. For apple tree cultivation, continuous pruning is required till the end of a season. New apple trees are pruned for first three to four years in order to provide better foundation of the tree, so that subsequently little cutting, setting and cultivating would become easy on these trees. It not only helps in increasing the size of the flower but, it also plays an important role in providing better quality apple which will provide high returns. If the stems are fixed properly through various cutting tools by farmers or labors, it will also increase production. This process is practiced before the growing season and it also leads to some cost as specialized labors are hired and paid for this purpose. Expect sign for this variable is also positive. Several other studies included pruning as an explanatory variable due to such importance in productivity of fruits especially (Albert *et al.* 2010).

Pesticide isalso used as an input. The purpose of pesticide is to kill insects and pests. Due to this, the quality of crops remains good which also increases its life and fetch a good price in the market. Expected sign of this variable is positive as pesticides increases Apple quality and thus, increases its yield. So such study has been viewed using pesticide as an explanatory variable yet.

RESULTS AND DISCUSSION

Using OLS technique, study analyzed the production function for Apple. Dependent variable is Apple Yield, which shows that either the output will increase or decrease against several inputs used in the production function. There was an econometric problem of Multicolinearity in the model after it was tested. The problem existed between two explanatory variables like fertilizer and pesticide. That is why, pesticide was further removed. Afterwards, again problem of Multicolinearity was tested through correlation matrix test and there was no problem found.

Table 1.OLS Model for Apple Production Function.

Dependent Variable: LOG(AY)

Variable	Coefficient	Std. Err	t-Stats	Prob.
C	-0.4506	1.6039	-0.2809	0.78
LOG(LS)	0.1590**	0.0835	1.9039	0.06
LOG(EDU)	0.1620**	0.0746	2.1708	0.03
LOG(FEX)	0.1353	0.1468	0.9213	0.36
LOG(FER)	0.3818***	0.0939	4.0621	0.00
LOG(PA)	-0.0696	0.2499	-0.2785	0.78
LOG(IRR)	0.1911**	0.0975	1.9585	0.05
LOG(PRU)	0.1049*	0.0805	1.3028	0.19
DUMMY	0.4326***	0.1174	3.6852	0.00
Adjusted R-squared	0.37	Returns to Scale	1.49	
F-statistics	6.72			

***, ** and * Significant at 1, 5 and 10 percent probability level

Source: Study Result

JB test was conducted to test normality of variables while White test was performed for testing Heteroscedasticity. P-value shows that variables are normal. Also found no evidence of hetero at 5% level of significance.

Adjusted R-squared is 0.36 which shows that overall model is a good fit as in this case, where data is a cross sectional (Table 1). Overall model is found to be significant as five out of eight explanatory variables shows positive result. This shows that mini dam plays a vital role in

apple production function. People of Kawas are better off as compared with Verchoom village for not having a mini dam.

Both dependent and independent variables are estimated in log term, hence, the coefficients of the explanatory variables are added which to find out if it possess increasing, decreasing or constant returns to scale. The sum of the coefficient values is 1.49 here and hence, experiencesincreasing returns to scale (IRS) which further shows that Apple Yield increases by more than proportional increase in the given explanatory variables.

Result shows that dummy variable is highly significant at 1 percent. One of the reasons is that mini dam provide water whole year. Up till 2 acre of land, no tube well water is required as dam water is sufficient for whole season. It is economical and farmers pay negligible price. Moreover, the water is full of minerals and impurities that help the apple to produce both quality and quantity. The duration of irrigation is more for the land which is irrigated by dam water than the land dependent over tube well only. No such study has shown such relation however, this is the first study presented highlighting the importance of dam in the production of apple which not only increases productivity, but, it improves quality, taste, shape, size along with reduction in cost of irrigation as dam water is almost free.

LS is positively correlated with the quantity of apple. The higher the size of the land more will be the output of apple and vice versa. The basic reason behind this result is that the size of land helps in growing more apple trees. As number of trees increases, the output per trees also increases i.e. if one tree could produce 12 crates, than 80 trees could produce 960 crates per acre of land. Furthermore, farmer could have the opportunity to produce more trees per acre of land with the increases in land size. In this way, per unit production is increased with the increase in size of the land. Thus, output would also be increased with increasing returns to scale. But, there is a limit to plant certain trees per acre. The recommended number of trees depends upon the variety of apple. It is its total biomass that matters. If we plant more trees than recommended, than there will be over lapping and that will adversely affect the yield. However, study shows that there exist an inverse relationship between farm size and productivity as small farmers produce more output than large does per acre due to properly managing the farm, efficient input use, lower labor cost(Ahmad &Qureshi, 1999).In addition to this, another study revealed an inverse relationship between farm size and productivity and mentioned that small

farmers maximize their inputs use up to a level where marginal productivity becomes negative. They also manage to produce high output per acre, without high levels of capital input use. Middle farmers use inefficient combinations of inputs while large farmers used maximum capacity which is why there exists an inverse relation(Kiani, 2008).

Education of the farmer is positively related with the output of apple. Reasons behind this could be many. Education provides exposure, a knowhow off and on the farm activities. It results in developing farmers thinking productively and brings about more ideas which help farmers to bring innovations in the production process. Farmers who attained education are producing high yield as compared with those who did not. That is the key in higher production of apple because most of the farmers during survey were quiet rigid, were not willing to provide any information and some of those who were interviewed, their production level was low relative to those who were educated. Apart from this result, a study showed similar result where positive relationship exist between education and agricultural productivity for rich countries only; while an insignificant relation for poor or developing countries because education leads to higher agricultural productivity (Riemers&Klasen, 2011). A positive result occurred again in Punjab study where education is significant with productivity level (Baksh*et al.* 2004).

Farming experience is insignificant with apple productivity. The reason is that proper management is required for better quality and quantity of apple instead of farming experience. Even if a farmer is highly experienced, but during some particular season, he could not give proper time to the farm, to look after the farm, to check the condition of apple during growth stages, and to check whether any input ratio exceeds or deficient, to hire more labors when required and harvest on time; it will not result in high yield as shown by the study. A Study conducted in Punjab regarding Cauliflower production also showed a direct relationship between yield and farming experience (Baksh*et al.* 2004).

Fertilizer has significant positive effect on the yield of apple.The reason behind this is that fertilizers provides nutrients to the crop and enhance growth. The key is to use high quality nutritious fertilizer having low price instead of mixing several fertilizers of high price. Specific ratio is required for the crop growth and those farmers, who pursue it, receive high output as in this case. Similar results were showed by the studies involving production functions where fertilizer was highly significant and positively affected the yield as it helps the crops to grow and

mature, provide nutrients that improve quality and size (Bathan&Lantican, 2010; Ahmad *et al.* 2005; Baksh*et al.* 2004).

Plant/ tree age is insignificant with a negative sign. Reason behind this is that nowadays, the size of the tree does not matter in producing high output despite the size of the tree is increased. It is due to the fact that already 70 to 80 trees are grown in per acre of land. When the size of tree is increased with age, the stems of tree are intersecting one another and it forces the stems to alter their direction. In this way, few stem are forced to face downwards where not only the size of apple is affected because also apple crop do not receive sunlight which is important for its growth There is yet no study which could show the impact of tree age with its productivity, however, one study showed the reason of planting apple trees in three northern districts of Baluchistan including Ziarat. Almost 50% farmers responded that they have planted trees to get high returns/ income (Khair*et al.* 2002).

IRR is positively significant. It is because of the fact that production process is based upon a specific irrigation cycle, requires water on every thirteenth or eighteenth day depending upon dam or tube well water. Reason behind its significance is that farmers in both villages are very conscious about irrigation. They provide water on time. Even if dam is not available, they manage it by other alternative source like tube well. The less is the cost on irrigation, more would be the output and vice versa. A study showed that irrigation number is significant with yield in Punjab. As irrigation number increases, output will increase and vice versa (Baksh*et al.* 2004.

PRU is also significant at 1 percent. One reasoncould be the provision of better foundation for a new crop to grow. It is done before the start of the season. Specialized labors are hired for such purpose. Pruning is one of the most important steps involved in healthy growth of the crop. If pruning is done properly, it will produce high quality crop which will also fetch a high price in the market. It is highly technical because if it is not done properly, it reduces the yield. Only unwanted, dry and weak roots are pruned. A study showed a direct relationship between pruning and blueberry yield (Albert *et al.* 2010).

Thus, Overall study shows that the impact of KawasTangi Storage Dam is positive on agriculture productivity. The beneficiaries of this mini dam are better off as

compared with the past. Existing orchard has been saved which was destroyed during the drought of 90's. More area is under cultivation now after the creation of mini dam. Command area has also been increased that generates more revenue to the farmers. The cost on irrigation in Kawas village is negligible due to mini dam. The quality of apple is high by using dam water which is why; the returns are also high as compared with other village. Despite both villages are having same conditions like climate, rainfall and crops grown etc. The main difference between their incomes (profit) is the cost on irrigation as shown in results.

CONCLUSION AND POLICY RECOMMENDATION

The study examined the impact of mini dam on agricultural productivity, particularly Apple, in the two villages of Ziarat district, namely Kawas and Verchoom. Eight explanatory variables were used, most of which are inputs in the production process. Empirical analysis was performed using Cobb-Douglas production functional from. It is concluded that overall model is significant and possess an increasing returns to scale. All variables are found significant except farming experience and tree age. Dummy variable is found to be highly significant which shows the impact of mini dam is very high and Kawas farmers are far better off than Verchoom mainly because of having dam. Furthermore, mini dams should be made in such a way so that it could store more water which will help it to reach the tail of the lower stream households who do not avail this facility. The size of the dam and capacity of reservoir should be sufficient to ensure sustainable yield based on the water balance studies and to accommodate the silt load over a project life of more than 30 years. Otherwise the silt load would be enough to fill the reservoir within the period of 4-6 years. For mini dams with limited storage capacity, the size of the spillway should be given due importance for flood control purposes. Access to agriculture inputs should be made easy and economical which will facilitate farmers to increase the yield and generate revenue. Land resource use should be used at optimal level to achieve high productivity and prosperity and hence, high returns. Sustainable use of water should be followed to save more water and avoid wasting it as water is a scarce resource.

REFERENCES

Ahmad, B., Sarfaraz, H., & Baksh, K. (2005). Factors Affecting Yield and profitability of Carrot in Two Districts of Punjab. *International Journal of Agriculture and Biology Vol. 5*, 794-798.

Ahmad, M., & Qureshi, S. (1999). Evidence on Farm Size and Land Productivity: Implications for Public Policy. *The Pakistan Development Review 38:4 Part II*, 1135-1153.

Albert, T., Karp, K., Starast, M., & Paal, T. (2010). The Effect of Mulching and Pruning on the Vegetative Growth and Yield of the Half-High Blueberry. *Agronomy Research 8(1),* 759-769.

Baksh, K., Akram, W., Raza, M. A., & Hassan, I. (2004). Determination of Factors Affecting Cauliflower Yield in Punjab, Pakistan. *International Journal of Agriculture and Biology Vol. 6*, 1056-1058.

Bathan, B. M., & Lantican, F. A. (2010). Factors Affecting Yield Performance of Banana Farms in Oriental Mindoro, Philippines. *J.ISSAAS Vol. 16, No.1*, 110-120.

Bengali.K (2009). Water management under constraints: the need for a paradigm shift. ln: Kugelman M, Hathaway RM (ed), Running on empty: Pakistan's water Crisis.Woodrow *Wilson International Centre for Scholars, Washington DC*.

Cameos, SPRM, Halcrow and ADB (2008). Effectiveness of Delay Action/ Storage Dams in Baluchistan: *Irrigation and Power Department, Govt. of Baluchista; Royal Netherlands Government.Final Report, TA 4560-PAK.*

Govt. of Baluchistan (2010).Development Statistics of Baluchistan. *Bureau of Statistics Planning and Development Department, Quetta.*

Govt. of Pakistan (2011). Pakistan Economic Survey (2010-2011). Ministry of Finance, Economic Advisors Wing, Islamabad.

Khair, S. M., Ali, A., & Wadhayo, A. (2002). Apple Production Practices and Constraints in Northern Baluchistan. *Socioeconomic Research Studies 2002-2003. PARC, Isb.*, pp. 1-17.

Kiani, A. K. (2008). Farm Size and Productivity in Pakistan. *European Journal of Social Sciences. Vol. 7, No. 2,* pp. 42-52.

MalteReimers& Stephan Klasen (2011).Revisiting the Role of Education for Agricultural Productivity*: Poverty, Equity and Growth.Courant Research Centre,Discussion Paper.*

Reimers, M., & Klasen, S. (2011). Revisiting the Role of Education for Agricultural Productivity. *Courant Research Centre, University of Gottingen*. *Discussion Paper.*

World Commission on Dams (WCD) (2000). Dams & Development: a new framework for decision-making. *Earthern Publications Ltd, London & Sterling, VA.*