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GJMBR-B Classification : *JEL Code: F52, O10*



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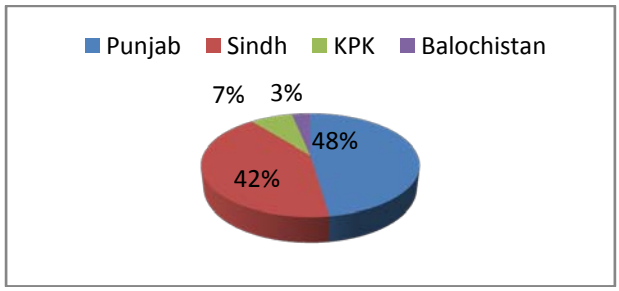
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I. Introduction

The primary inputs for agriculture are water and land. Khyber Pakhtunkhwa (KP) province cultivable area is 2.72 million hectares, out of which only 1.65 million hectares is cultivated while the balance 1.07 million hectares is cultivable waste[1]. KP's total irrigated area is 0.80 million hectares thus 71% of balance cultivable area is arid. These arid areas have no assured water for irrigation, which is the lifeblood input for agriculture. The rainfall is of erratic nature which jeopardizes the investment in rainfed agriculture and hence causes widespread food insecurity in Khyber Pakhtunkhwa. Drought comes after each 3 or 5 years in KP during which these areas are severely affected. An estimated amount of Rs 14 billion were lost due to drought in the year 2000-01 by KP's farmers (KP Agriculture Policy, 2005). On the other side, the rain causes heavy flash floods which destroy crops, irrigation infrastructure, houses. The July 2010 floods have caused damages to the tune of around Rs 185 billion to the province while 1,000 people lost their precious lives. In such situations, farmers normally minimize inputs to reduce risk of loss and mainly depend on off-farm income for their sustenance. (KP Agriculture Policy 2005).

The River Indus is the main source of irrigation water in Pakistan. The water of Indus River has been distributed among the four provinces in Pakistan. The respective share of each province is shown in the following figure.

Figure 1 : 1 % age Provincial Share of Water in River Indus



Source : Water Apportionment Accord 1991

The KP share in the perennial flow of river Indus is 8.78 million acre feet (maf)/117.35 maf which is 7%. (Water Apportionment Accord, 1991) The present irrigation withdrawal is 5.62 to 5.97 MAF (say 6 maf) which shows that province is unable to utilize its due share of almost 2.78 maf. The KP Government has planned a number of schemes to utilize its water, however Federal Government is reluctant in the financing of such schemes. i.e. Chashma Right Bank Canal 1st Lift project costing Rs 62 billion is pending in Federal Government for the last 07 years.

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[1]Cultivable waste comprises that un-cultivated land which is fit for cultivation but was neither cropped during the year nor in the preceding year.

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The KP per capita water availability is around 513.445 cubic meter/capita which is far less than the national and international level i.e. around 1200 & 1000 cubic meter/capita (KP Irrigation Department, 2010). Thus the province is in highly water stress situation. The depletion of ground water is another big issue for the province. A number of various government departments install tube wells throughout the province without any proper planning due to which the province will face acute groundwater shortages. The Irrigation department has initiated complete ban on the installation of tube wells but due to political interference the decision could not be implemented. A study was conducted for ground water in 1988 in the province which needs to be updated. The Irrigation department has proposed a study for updating but the Planning & Development Department is reluctant in its financing. In such like situation there is strong desire to construct small scale reservoir and dams.

A total of 15 numbers small dams have been constructed in the KP province. The basic purpose of these dams is to conserve every drop of available floods and rain water for agriculture. However no evaluation or impact study for these constructed small dams has been carried out. It is not known that whether the precious resources utilized on these dams are fruitful or not. In Punjab Province various impact studies has been carried out for constructed small dams. So there is a strong desire for an impact study of small dam in the Khyber Pakhtunkhwa. An attempt is made in this study to investigate the impact of Mattani Aza Khel dam District Peshawar, on the agriculture production and overall socio economic conditions of the area. This study documents (i) the socio-economic conditions of the farmers, (ii) compare the crop yield, cropping pattern and crop revenues before and after dam construction & (iii) highlight issues and suggest policy interventions.

II. Review of Literature

Bhutta (1999) investigated the impact of small dams in Pothowar plateau. The study revealed that the dam was irrigating 6,000 hectares land against its initial objective of 14,000 hectares land. The larger portion of land was not leveled. The major factor of not achieving the project target was inactive water users association. The other problems highlighted were lack of adequate operation and maintenance activities, uneven water distribution, damaged courses, and unleveled land.

Murray, Sakthivadivel and Amarasinghe (1999) assessed the impact of rehabilitation interventions on the performance Gal Oya Left Bank irrigation system, Sri Lanka. They found that rehabilitation had significantly improved the performance of irrigation system. The irrigated area was increased while the irrigation supply per unit area was decreased. The productivity was highly increased after rehabilitation. They suggested that in addition to the physical infrastructure, the institutional improvement should also be made so that to improve the performance of an irrigation system.

Aga Khan Rural Support Program (2000) studied the impact of 13 small irrigation schemes in Baltistan, Gilgat and Chitral. The internal rate of return of the projects was from 13 to 56 % while cost benefit ratio was from 1.23 to 3.63. A total of 35 % new area was brought under cultivation. The value of land was significantly improved. The raising of livestock was increased due to availability of water. The tree cultivation was started which will improve the soil structure and fertility. The woman workload was increased due to increase in intensity and area of agriculture. The cropping pattern was changed from traditional to high value market crops such as vegetables and fruits.

Saleh and Mondal (2001) evaluated the impact of Bakkhali and Idgaon rubber dam projects, Bangladesh. They examined hydraulic, agricultural and socio-economic factors of the dam in the area through field surveys. They found improved socio-economic indicators of the project and termed the project a viable project. The crop yield and water productivity had improved in both projects however new area irrigated was very less as compare to the actual targets. The actual water availability was much less than the targets as the same were overestimated in both projects during feasibility study stage. The utilization of water in the Bakkhali project was much better than the Idgaon project due to the proper management of irrigation water. Similarly the water supply was sufficient in Bakkali project as compare to Idgaon project.

Pender and Berhanu (2002) investigated the impact of small irrigation schemes in Tigray, Northern Ethiopia. They observed significant improvement on agriculture sector due to these projects. They observed considerable increase in the use of agriculture inputs such as oxens, labor, fertilizer, improved seeds. The crop production had significantly improved. They found that crop production was 18% higher than in rainfed areas. Benin et al (2002) also found similar results in a study in Amhara Region, Ethopia. They observed increased use of agriculture inputs such as fertilizer, chemicals, improved seeds, pesticides, labor after development of small scale irrigation schemes.

Hussain, Hanjra, Thrikawala and Wijeratne (2003) investigated the impact of irrigation investment on poverty reduction. A sample of 858 households was interviewed from Uda Walawe Left Bank Irrigation System, Sri Lanka. Household survey was conducted 5 times during 2000-02 by employing before and after approach. They found that availability of irrigation water had strong effect on poverty reduction and improving welfare of the rural areas. It was observed that crop intensification, land productivity, value of production per hectare and level of crop diversification were on higher

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side in irrigated areas as compare to rainfed areas. At irrigated areas the labor employment was stable due to which it negatively affects chronic poverty.

Chen and Ravallion (2003) studied the impacts of Southwest Poverty Reduction Project implemented in the poor areas of China during 1995-2001. The project covered interventions in agriculture, education, health, off-farm employment, rural infrastructure and enterprise development, and Institution building. They found an average income gain over five years of around 10% of baseline mean income (1995), representing an average return on the project's disbursements of about 9-10%. There was no impact on the consumption poverty using international "$/day" poverty line, however for lower poverty lines, there were indications of significant impacts on consumption poverty. They hold that full impacts of a project can only be calculated after a considerable period is passed by its completion.

Bhattarai & Narayanamoorthy (2003) studied the marginal impact of irrigation and other factors inputs on agriculture productivity in India. They used annual time series data from 1970 to1994 for major 14 states of India. They found that the marginal impact of irrigation on growth of productivity of all inputs is positive and significant with the elasticity of 0.32 while the elasticity of other factors such as fertilizer, High Yielding Variety and road infrastructure is only 0.04 to 0.09. They found strong inverse relationship between poverty and percentage of gross area irrigated. The study reveals that irrigation is strongest factor in reduction in poverty as compare to rural literacy, HYV, fertilizer. While the road infrastructure did not showed any impact on poverty reduction.

Hussain & Hanjra (2004) found higher household income due to higher cropping intensity, higher crop and labor productivity and higher employment in irrigated setting as compare to the rainfed settings. They found strong direct and indirect linkages between irrigation and poverty alleviation. As production and supply shifters Irrigation investment have strong positive effects on economic growth. Irrigation alleviates both permanent and temporary poverty as it is productivity enhancing, growth promoting and poverty reducing. Irrigation benefits land holders in short term while the landless people in long term. They suggested that in order to benefit poor and alleviate poverty, irrigation should be extended along with other policy measures i.e. equitable distribution of land, integrated water resource management, equitable and adequate good quality surface and groundwater, modern production and cultivation technologies, shift to high value market oriented production and opportunities of sale of output at low transaction cost.

Ashraf, Kahlown & Ashfaq (2004) studied the impacts of Khasala, Jawa and Dhok Sanday Mar dams in Punjab. They found that after construction of these dams, the income, land use, crop intensities and crop yield of the farmers have been considerably increased. The cropping pattern has been shifted towards high valued market oriented crops. The water table has improved. The per hectares income in Kharif season ranges $ 833-1000 and Rabi ranges from $ 1000 to 1433 for Khasala and Jawa dams respectively while it is $ 217-617 in Kharif & $ 417 to 617 in Rabi for DS Mar dam. The irrigation methods used were still conventional. They suggested that an integrated program should be developed and implemented in the command area of these dams for the effective utilization of available water and development of irrigation infrastructure. They contended that even more area can be irrigated with the same available water and infrastructure if it is managed properly.

Munawar, Zakir and Muhammad (2004) studied the impact small scale irrigation on the agriculture productivity and poverty level of the farmers in the marginal areas of Punjab, Pakistan. The study covered data of nine tehsils of Pothowar Plateau for 2002-03 period. They found that poverty level is high in rainfed areas as compared to irrigated areas. The poverty head counts were 26% in irrigated and irrigated plus rain-fed areas while it was 37 % in the rainfed areas. The major portion of annual income of poor was from agriculture while for non-poor it was business. Similarly major portion of poor expenditure was on food. The agriculture productivity and profitability of the poor farmers is low as compare to the non-poor farmers, while the cost of production is higher of poor farmers as compare to non-poor farmers. They found strong link in the increase of crop production due to small scale irrigation schemes, which will ultimately decrease poverty in the study area.

Pavlov, Roerink, Hellegers and Popovych (2006) studied the profitability of North Crimea Canal irrigation system in Crimea, Ukraine under market economy. They found that irrigated agriculture is profitable under market economy. The cost of irrigation system can be recovered from the water users. They suggested that irrigation cost can be reduced at farm and distribution level.

Ringler, Rosegrant, Cai and Cline (2006) studied the possible consequences of changes in future water demand for agricultural and ascertain possibilities to provide regular water supplies for irrigation. They discussed that the poor nations will face severe food and water shortages in 2025, which will lead to chronic poverty and malnutrition in these nations. To tackle water scarcity problems, these nations should highly invest in water infrastructure and Institutional reforms should be introduced in water management. With the same policy, water use efficiency of existing system can be improved. An integrated water management approach should be undertaken with specific focus on rain-fed agriculture. The research in agriculture should be encouraged. In irrigation sector, improvement should be initiated at technical, management and institutional

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levels. They propose that for each region, agriculture and water policy should be devised according to its agro-climatic conditions, relative water shortages, level of agricultural growth. At the end they concluded that such policies are difficult to implement as it require financial resources and political will.

Cheema and Bandaragoda (2007) studied the impact of of Mirwal & Shahpur small dams in Punjab, Pakistan. They found that in both dams there was no effective warabandi among the farmers. The existing warabandi was not followed by the farmers. The water conveyance network for both the dam was not properly maintained due to paucity of funds and manpower. The beds of canal were ruined and bushes were grown in cracks which impede water flow. It was observed that most of the areas under the command of these small dams were not leveled. The farmers were facing non-availability of other agriculture inputs such as fertilizer, pesticide, good quality seed etc. At the end they suggested that Government should introduce an effective and justified warabandi system in the area, provide sufficient funds for operation and maintenance of the canal and provide other agriculture inputs at right time and low prices.

Cakmak, Kibaroglu, Kendirli, and Gokalp (2010) studied the performance of transferred irrigation system in Turkey. The data collected for year 2003 was compared with benchmarking indicators. They found that the performance of irrigation schemes had been improved considerably after its transfer to the water user association. The cost of maintenance had been decreased while the revenue from the systems had been increased. The water supply in all the schemes had been improved significantly. Both the financial performance and production performance ratios showed improvement after the transfer of these schemes.

Bantero, Ayana, Awulachew and Seleshi (2010) studied the impact of community run Hare irrigation scheme in Southern Ethiopia. Data were collected through filed surveys and group discussions. They found significant improvement in the overall agriculture production and socio economic conditions of the farmers after the project. The farmers at tail were facing shortages of water as compare to the farmers at head and mid of the canal. In order to use maximum use of available water, they suggested improved institutional and management system of the irrigation system.

Sisay, Katrien, Amare and Tilahun (2011) studied the impact of small-scale irrigation scheme in Blue Nile, Ethiopia. They found positive impact of irrigation scheme on the overall agriculture production, however the application of water was not optimal. The water was not provided to the crops as per requirement due to which huge volume of water were being lost. The high price of pump water compelled water management association to use deficit irrigation and minimize water losses. They suggested night storage mechanisms, optimal irrigation scheduling, and empowerment of farmers for improvement of water productivity.

Owusu, Namara, Kuwornu (2011) studied the impact of irrigation on the social welfare in the rural savannah region of Ghana. Using propensity score matching (PSM) and switching regression techniques it was found that irrigation water availability had positively affected the socio-economic conditions of the people. The net farm income after irrigation water has shown significant increase. They strongly recommended construction of irrigation systems for poverty reduction in both regional and national level.

Bacha, Namara, Bogale and Tesfaye (2011) studied the impact of Indris irrigation system, Ambo district Ethiopia on poverty reduction. Data were collected through field survey from a sample of 222 respondents using with and without project approach. They found significantly higher poverty indicators in without irrigation settings as compare to with irrigation settings. Other than irrigation, the level of household expenditure was also affected by farm size, raising of livestock, land productivity, and family size. They suggested development of irrigation schemes throughout the country for reduction of poverty.

III. Material and Methods

It is an empirical study based on primary data collected from the selected farmers. The Mattani Aza khel dam Peshawar was selected for the study. The dam is located at 35 km southeast of Peshawar city. The catchment area is 49 sq-miles drained by Aza Khel Khawar. The average rainfall of the area ranges from 20 inches to 25 inches. The rain comes mostly during winter and spring i.e. December to April (PC-I). The dam was completed in 2004 with completion cost of Rs 58.206 million. The service area is the village Aza Khel. The total numbers of farmers were around 850. The dam was selected due to its nearest location to the Peshawar City.

A reconnaissance survey was conducted to form scheme typology and get familiarized with the study area. Key activities during reconnaissance were searching for available documents, identifying key informants and first hand information on the dam location, performance, service area etc. Primary data was collected from household survey. An interview schedule/questionnaire was used which was pre-tested and improvements were made in line with objectives of study and ground realities. The household survey collected data regarding personal household information (age, family size, education level, means of income), Farm information (tenural status, farm size, yield, cropping pattern, use of machinery, livestock etc). The farm information was both for before and after dam. Focus group discussions were made with elder

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community, Irrigation department officials and Agriculture department officials. The secondary data includes published documents such as feasibility studies, PC-I, PC-II, KP Development Statistics, KP Annual Development Program, evaluation reports etc. The sources for the secondary data were Irrigation Department, Small Dams Organization, Agriculture Department, District Revenue Offices, Pakistan Council of Research in Water Resources, Peshawar Agriculture University, Peshawar.

The total numbers of farmers were around 850 in the command area of small dam. A sample size of 60 respondents was selected using statistical technique. The farmers were interviewed randomly while 03 different setting (Jirga) were made for group discussions with elders farmers. The paired t-test was applied to test the significance of the data on "before and after" scenario.

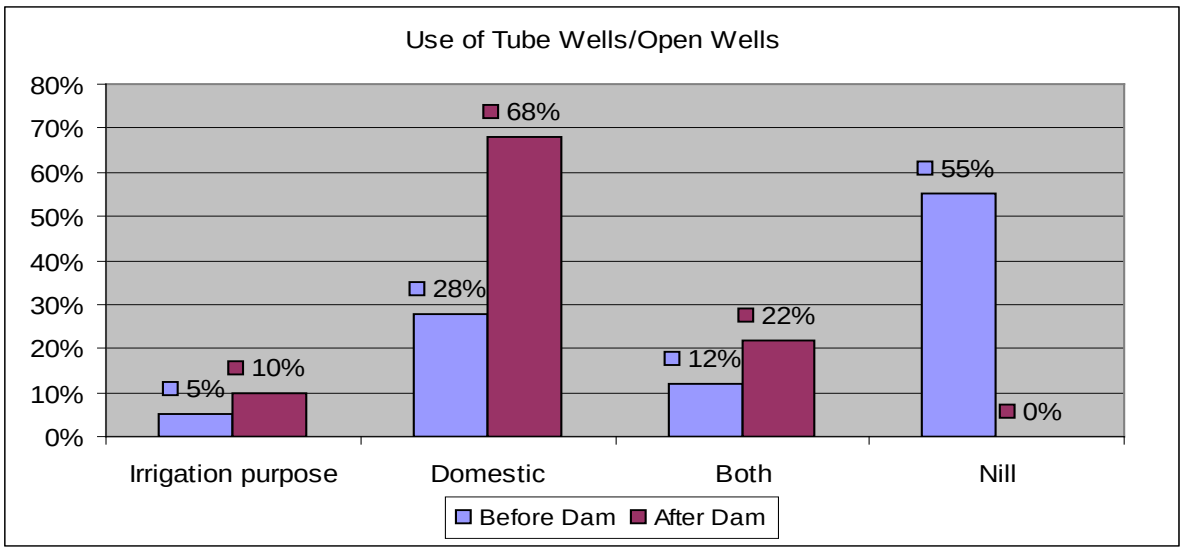
IV. Results and Discussion

a) General Information

In the study area, the average age of farmers was 49.48 years ranging from 17 to 90 years. Seventy percent of the respondents were between the age of 30 and 60 years. The education level was very low in the study area. 62% respondents were illiterate. Out of total 38% literate, 13% respondents had education of primary level, 7% middle, 7% matriculate, 3% intermediate, 8% graduate level and above. There was no tenant in the area as all farmers possess their own land. After dam, some farmers rent in land as their own land was not sufficient for agriculture. Owners were 83 % while 17% were owner-cum-tenant. Majority of the respondents were in small landholding category. 66% of farmers had landholdings less than 5 acres while 34 % between 5 to 9.5 acres. The major 50% of respondent posses land between 2.5 to 5.0 acres. The average family size of respondent in the study area was 13 ranging from 6 to 25. 50 % of respondents were in family size from 11 to 15. Farming was uniform occupation of all the respondents. In addition to farming, 26.66% respondents were doing businesses, 41.66% services while 31.66% were in multiple employment categories.

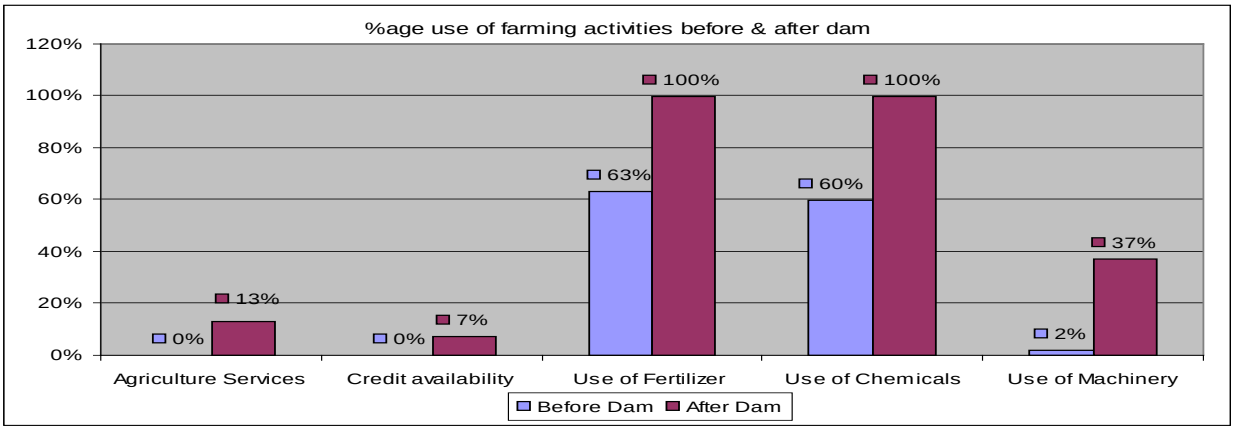
b) After and Before Dam Comparison

After construction of dam, farmers have got afresh life. Before dam 100% respondents were producing for domestic use while after dam 30% farmers were producing for domestic use, 13% for market purpose while 57% for both domestic use and market purpose. Before dam the ground water was depleted and people were facing acute shortages of water. 55% respondents could not use ground water for any purpose, 5% were for irrigation, 28% were for domestic uses. After dam construction, 68% uses were for domestic purpose, 10% for irrigation purpose, 22% both. The people were happier for dam much for their ground water recharge than to the availability of water for irrigation.



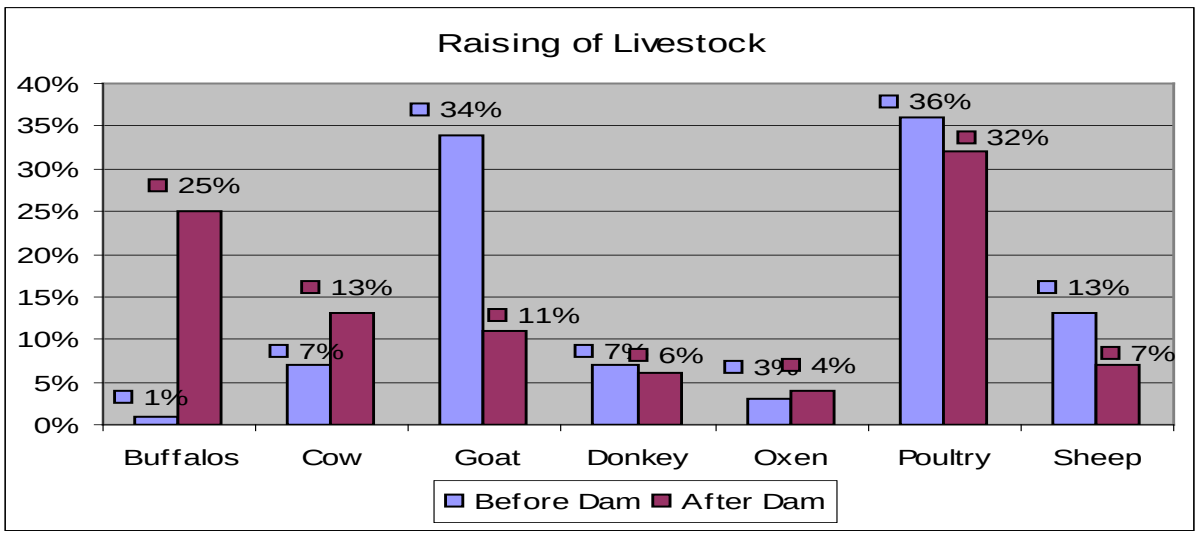
The agriculture extension services were un-available both before and after dam. A slight increase of 13% was observed after dam but the farmers were not happy from their services. No formal credit facility was observed in the sample respondents. Small farmers borrow from big farmers for agriculture and non-agriculture purposes. A slight increase of 7% credit availability was observed after dam construction. Before dam construction, 63% farmers were using fertilizer while after dam 100% farmers were using fertilizer. Similarly before dam, 60% farmers were using chemicals while after dam 100% farmers were using chemicals. Before dam only 2% respondents were using machinery for farming while after dam it improves to 37%. 4 farmers purchased tractors after dam, which they used for their own farming and also rent it out to other farmers. 63% cof respondents were still useing oxen and other conventional farming techniques.

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c) Raising of Livestock

The number of live stock had been significantly increased after the dam. Before dam there were 5 buffalos among the respondents while after dam it has been increased to 177. Similarly the number of cows and oxen's were doubled. The number of goats and sheep's were decreased after the dam. The milk was not salable however other milk items were sold. The trading of livestock had also been substantially increased.

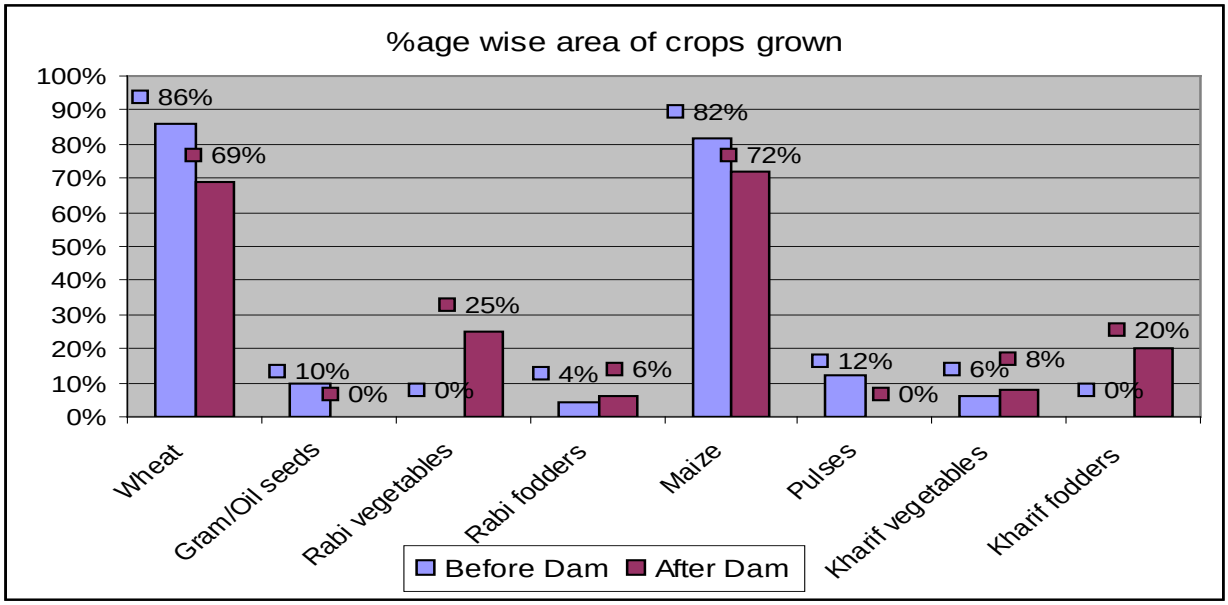


d) Cropping Pattern

Cropping pattern is the distribution of land to the different types of crops grown in a given year. With the construction of dam, the cropping pattern of study area has been converted from inferior to superior. There were two cropping seasons i.e. Rabi & Kharif in the study area. Before dam Rabi crops were wheat, gram, oilseeds and Barley while kharif crops were maize, sor/mullets and pulses. After dam Rabi crops were wheat, vegetables such as potato, onion, tomato, peas, reddish, carrot, cabbage & Shaftal while kharif crops were maize, vegetables such as lady finger, tinda, pumkin, bitter gourd, tomato, garlic.

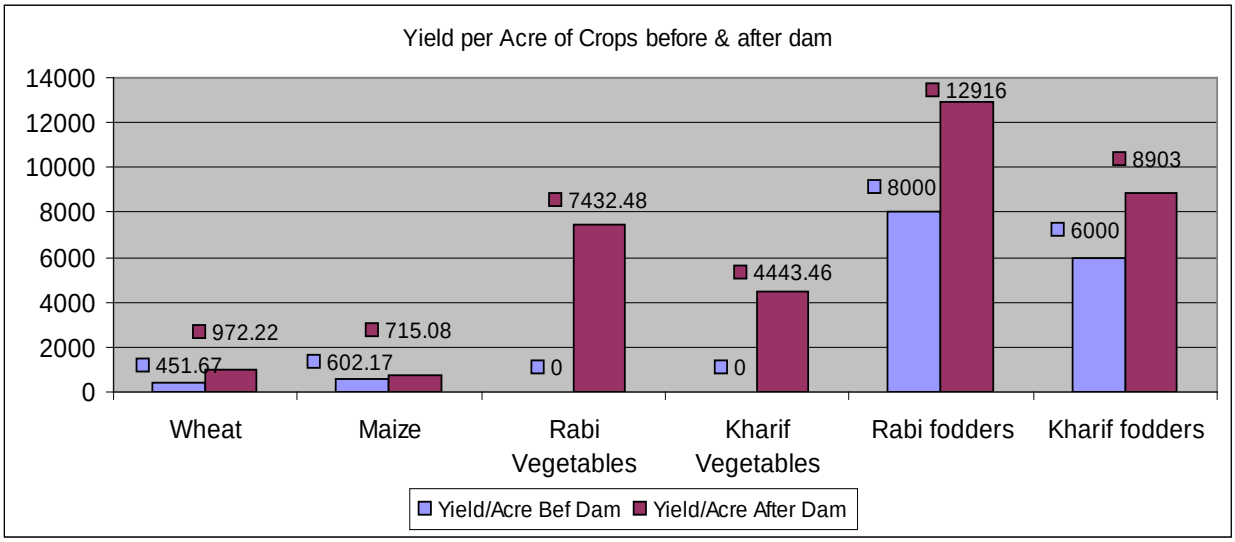
In Rabi season, before dam wheat consists of 86% cultivated area, gram & oilseeds consists 10% while fodders 4%. After dam Wheat was 69% of the croppage area, vegetables 25% and Shaftal 6%. The average farm use in acres during Rabi has been increased from 23 to 34 acres. The yield of wheat was improved from 451.67 kg/acres per acre to 997.22 kg/acre due to the availability of water, which was a 115% increase. The fodder namely barley were changed to the Shaftal. The yield of Barley was 8,000 kg/acre while yield of Shaftal was 12,916 kg/acre. In Kharif, before dam maize was grown on 82% of cropage area while after dam it is around 72%. The average area of maize was 18.86 acre before dam while 15.84 acre after the dam.

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e) Yield

The yield was also improved from 602.17 kg/acre to 715.08 kg/acre, which was 25% increase. In addition to the maize, sor/mullets was around 5% while pulses 7% before dam, while after dam it was not grown. After dam kharif vegetables were grown 20% of the total cropage area. The average farm size of farm during Kharif before and after the dam was almost same i.e 22. The yield of Rabi vegetable was 7432.48 kg/acre while kharif vegetable was 4443.48 kg/acre. Common Kharif fodders were Cheery/jowar both before and after the dam. However its yield was improved from 6000 kg/acre to 8903 kg/acre after the dam, which was 36% increase.



f) Revenues

The paired t-test was applied on the revenues of crop production of individual respondents before and after the dam. The current market prices were used for before and after dam production so that to remove the effect of inflation. The individual farmer average crop revenues was Rs 61,452 before dam while it has improved to Rs 243,373 after construction of dam. The calculated t-test value was found much higher it was concluded that the there is significant increase in the revenues of crop production after the dam.

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Table 4.1 : Pair Wise Comparison of Crops revenues

Pair		Mean	N	T	Df	Sig. (2-tailed)
Rabi	Revenue before Dam	37,330	60	17.162	59	.000
	Revenue after Dam	180,416	60			
Kharif	Revenue before Dam	24,122	60	14.062	59	.000
	Revenue after Dam	62,956	60			
Total	Revenue before Dam	61,452	60	17.045	59	.000
	Revenue after Dam	243,373	60			

V. Conclusion & Recommendations

The traditional cropping pattern has been shifted to the market oriented crops while yield of almost every crop has been improved. The number of livestock has been increased substantially. The water table has improved and wells were recharged as before dam construction people were facing acute shortages of water for domestic use. The crop revenues has been increased significantly. The issues highlighted were uneven distribution of water, lack of water user association, lack of agriculture extension support services and credit facilities, improper maintenance of canal. However if these problems were addressed, more benefits can be reaped from the dam water. The following are recommendations of the study:

- The overall impact of the dam was highly significant on the agriculture improvement in the study area. The small dams are highly desirable and it is strongly recommended that small dams should be constructed throughout the province.
- The water distribution was uneven. The Irrigation department should carry out new warabandi based on the requirements of all the farmers and implement it accordingly.
- The water channels at some reaches were not lined due to which tail farmers were facing water shortages. The whole channel should be lined so water losses can be reduced.
- The farmers were not contacted during Annual operation and maintenance. The farmers were of the opine that they could carryout the operation & maintenance activities by themselves in lesser cost than the Irrigation department.
- The agriculture extension services were not provided in the area. The agriculture department should take immediate steps to provide such services.
- The credit facilities should be made available by the government in the area.
- The other small dams of the Khyber Pakhtunkhwa may be studied for its impact on the farmers.

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