ECONOMIC AND FINANCIAL ANALYSES

A. Introduction

1. The economic analysis of the project has been undertaken according to the guidelines of the Asian Development Bank (ADB) and describes the economic rationale for public intervention. The analysis quantifies the economic benefits and costs associated with the extension of the Pehur High Level Canal (PHLC) in the Swabi District of Khyber Pakhtunkhwa Province (KPP) and measures the impact of the project on the whole economy. Financial values were converted to economic values by removing the effects of government interventions and market distortions.

2. Two scenarios—without project and with project—were compared to determine the economic net benefits of the project. The without-project scenario assumes a continuation of current agricultural practices, which are largely *barani* agriculture[1] and intermittent low-value irrigation of wheat and rapeseed and mustard (oilseeds) in the *rabi* season,[2] and maize and groundnut crops in the *kharif* season.[3] The with-project scenario assumes increased irrigation during the rabi and kharif seasons due to improved water availability from new irrigation infrastructure attributable to the project. It is expected that the project would lead to (i) greater area of irrigated crop production and reduced barani crop production, (ii) higher crop yields, and (iii) a shift to the production of high-value crops.

B. Macroeconomic Assessments

3. Pakistan's agriculture sector grew by about 3.4% per annum in 1970–2013.[4] The highest growth rates achieved during this period were 11% in 1985, 10% in 1992, and 12% in 1996. On the other hand, the agriculture sector experienced negative growth of -5% in 1984 and 1993, and -2% in 2001 due to severe droughts that occurred during these periods. Based on FAO data,[5] the pattern of growth in the country's overall real gross domestic product (GDP) has been closely linked to that of the agriculture sector despite the declining share of the agriculture sector to the overall GDP. Even with the sector's modest growth and declining share, it contributed around 27% or roughly $18.3 billion per annum in real terms to the country's average annual $73 billion real GDP at 2005 constant prices and employed more than 44% of the country's labor force.

4. Pakistan's main agricultural products are buffalo milk, cow's milk, wheat, rice, and cotton. These crops are mostly grown in the Indus River plain in the provinces of Punjab and Sindh, which in 2010 accounted for roughly 55% and 19% of the country's total agriculture production area respectively.[6] From 2000 to 2013, buffalo milk had the highest average contribution to the annual agricultural GDP at roughly $5.5 billion, which is equivalent to about 19.6% of the average annual agricultural GDP of about $28.4 billion. Over the same period, buffalo milk was closely followed by the production of wheat and cow's milk. On average, wheat contributed $4.0 billion (14.1%) and cow's milk $3.1 billion (10.8%) of the average annual

[1] *Barani* agriculture refers to dry farming practice.
[2] *Rabi* season refers to the dry or winter-spring season, often from October/November to May.
[3] *Kharif* season refers to the rainy season, often from May/June to October.
[4] The average annual growth rate for the agricultural sector is 4% from 2000 to 2013.
[5] FAOSTAT.2015 [provide a complete reference as set out in the ADB Handbook or Style and Usage, p. 94 onwards]
[6] Pakistan Agricultural Census. 2010. [provide a complete reference]

agricultural GDP. Other major agricultural products include rice, cotton lint, sugarcane, maize, and potato.

5. The widespread poverty in Pakistan has been rooted to the highly differentiated structure of land ownership. The landlessness in the country has become so severe that only roughly 2.0% of the households own nearly 50% of the land while only 0.1% of the households own more than 2.0 hectares. As of 2000, the average farm size in Pakistan is 3.1 ha, which has significantly decreased from 1973 when the average farm size was 5.3 ha.[7] Unfortunately, land reform provisions have been absent in development plans during the period 2010-2015. The last major attempt to redistribute land, which came after Pakistan's green revolution in the 1960s, was largely ineffective due to inefficient implementation, political turbulence, and the power wielded by large landowners who had strong political influence. This land reform policy only resulted in insecure tenancy arrangements, which prohibited long-term farm investments.

C. Demand Analysis

6. On average, around 51.5% of the country's dietary energy is derived from cereals.[8] However, the sluggish growth in the production of cereals such as rice, wheat, and maize underscores the critical need to address food insecurity issues, especially since the contribution of cereals has been declining by an annual average of 0.5%. From 1990 to 2009, the average annual per-capita food production value is about $179.3, increasing at an average annual rate of 0.5%. In spite of the annual increase in food production value, FAO reports that the average annual food deficit in the country is about 171.3 kcal/capita/day from 1990 to 2009. Prevalence of undernourishment has remained critical for the period 1996-2016 with 20% incidence.

7. It is imperative to improve the productivity of the agriculture sector in view of the declining per capita food supply faced by the country. Between 1990 and 2011, the per-capita food supply decreased by an average rate of 1.1% per annum. This average decline in per capita food supply was accompanied by the volatility of domestic food prices, which have distorted the production decisions of farmers and resulted in productivity losses.

8. Although the share of the agriculture sector to the national GDP has been in decline, it does not necessarily suggest the economic diminution of the sector, because the country's real GDP relies heavily on the performance of the sector. The plateau in the sector's growth may be attributed to the obsolescence of existing agricultural technologies, the inefficiency of the farm tenure system, and, especially, the inadequacy of basic infrastructures such as irrigation.

9. Water is scarce in the project area and there is a strong demand by farmers for sustainable supply of irrigation water to increase the efficiency in the use of farm resources. Having a sustainable supply of irrigation water could raise the cropping intensities and crop yields, and may incentivize farmers to venture into the production of high-value crops. These changes in the agricultural production landscape could result in better and more sustainable rural farm incomes.

10. The favorable climate and cheap labor for growing high-value crops, as they need much less land and water for production, will help to increase farm incomes in the project area. The

[7] Sial, M.H., Iqbal, S., and Sheikh, A.D. 2012. *Farm Size–Productivity Relationship*. Pakistan Economic and Social Review. Vol. 50, No. 2 (Winter 2012), pp. 139-162 (as reported by FAO [2001]).

[8] FAOSTAT. 2015. [provide a complete reference]

project area is suitable for shifting towards the growing of vegetables, orchards, and other high-value crops. Moreover, high-value crops command premium prices, particularly during off-season periods. Net profit against the investment is much higher for these crops compared with traditional crops. The products are in high demand all over Pakistan and could be marketed easily in the project area as well as in nearby urban centers like Swabi, Rawalpindi, Islamabad, Charsada, and Peshawar. Places such as Mardan and the nearby vicinities of the project area are considered important markets after shifting to producing and marketing these crops.

11. As of December 2015, the only crops grown in the project area are wheat, maize, and oilseeds. The annual production is about 4,458 tons of wheat, 956 tons of maize, and 560 tons of oilseeds. Production is expected to increase to 9,374 tons of wheat, 8,230 tons of maize, and 1,017 tons of oilseeds with the project at full development. In addition, annual production of about 26,956 tons of fodders; 29,343 tons of vegetables; and 4,337 tons of fruit are also expected at full project development. These increases are significant for the Khyber Pakhtunkhwa province, which currently provides a moderate contribution to the national production of wheat, maize, rapeseed, and fruits. As such, incremental production can be marketed easily even within the project area without substantial risk of saturation since these increases are not sizable at both the national and provincial levels (Table 1).

Table 1: Production Profile With- and Without Project

	Production 2013–14			Project Area in 2014		Project Area in 2022	
Major Crops	**Pakistan ('000 tons)**	**KPP ('000 tons)**	**KPP as % of Pakistan 2014 Production**	**Production ('000 tons)**	**% of KPP 2014 Production**	**Production ('000 tons)**	**% of KPP 2014 Production**
(1)	*(2)*	*(3)*	*(4) = (3)/(2)*100*	*(5)*	*(6) = (5)/(3)*100*	*(7)*	*(8) = (7)/(3)*100*
Wheat	25,979	1,363	5.2%	4.46	0.33%	9.37	0.7%
Maize	4,944	915	18.5%	0.96	0.10%	8.23	0.9%
Rapeseed	231	7	3.0%	0.56	8.12%	1.02	14.5%
Fruits	6,638	420	6.3%	-	0.00%	4.34	1.0%

KPP = Khyber Pakhtunkhwa Province.
Source: Bureau of Statistics, Government of Pakistan. 2015. *Consultant's Economic Survey, 2015*.

D. Rationale for the Proposed Project Investment

12. The present condition of low yields and traditional crops in the project area is due to the inadequate supply of irrigation water. The increase in cultivated area, crop intensities, and yields in the command area is not possible without improving the facilities for surface irrigation water.

13. The project area is endowed with productive fertile land, plenty of water resources, and a climate that is conducive to the production of many types of food and non-food crops. In order to make agricultural production sustainable and improve socio-economic conditions, the government has focused on efforts that utilize the potential of the existing irrigation canals. Towards this end, it is planned that irrigation facilities of the Pehur High Level Canal be extended to bring 8,727 ha under canal command, and to turn the rain-fed area into full irrigation for crop cultivation.

14. An intervention such as this project is necessary because farmers, in their own private capacity, are not incentivized to invest on irrigation improvements because of the prohibitively high financial costs. Moreover, the project would not generate sufficient direct financial returns for private sector investors. Since irrigation water is a "public" good, investments on irrigation development could only take off if undertaken by the government.

E. Project Scenarios

15. **"Without Project" Scenario.** The "without project" scenario involves no intervention for the provision of irrigation water supply. Under this scenario, the area will remain dependent on sporadic rainfall and a limited quantity of groundwater and there would be no change in the present level of agricultural practices, input usage, and cropped area.

16. Analysis of primary and secondary data indicates that the existing agriculture situation in the command area, cropping pattern, and intensities would remain unchanged under the rain-fed conditions without provision of regulated irrigation. Therefore, without regulated irrigation supplies (i.e., without project) the existing agriculture output will not change for the better and the land will become drier and less productive. This scenario is further described as follows: (i) cropping intensity in project command area is estimated at only 52.4%, (ii) the principal kharif crop is maize and farming in the command area is below the subsistence level and is unsustainable, and (iii) the yield level is low due to erratic and inadequate rainfall resulting in shortage of water.

17. **"With Project" Scenario.** With the provision of irrigation water supply to the existing non-irrigated command area, the cropping pattern, cropping intensity, and crop yields would improve. In this scenario, an area of 8,727 ha, where rain-fed agriculture is being practiced will be brought under full irrigation. Timely and adequate volume of water availability will be ensured. The present level of cropping intensity will increase from 52.4% to 150.6%. Furthermore, high value crops including fruit and vegetables will be grown alongside traditional crops such as wheat and maize, which will result in good land use practices and increased farm incomes. This will contribute to improved environmental conditions, particularly in the primary impact area, and enhanced living standards in the project area, especially in the secondary impact area.

F. Major Assumptions

18. **Key assumptions.** (i) The world price numeraire was used in the economic analysis, (ii) a standard conversion factor (SCF) of 0.93 was used to convert a financial price into its economic price for non-tradable goods, (iii) a shadow wage rate factor of 0.73 was used for unskilled labor, (iv) a discount rate of 12% was considered as the opportunity cost of capital, (v) the economic life of the project is assumed to last 30 years, and (vi) the economic value of the acquired agricultural land was calculated as the forgone net economic value from the land's highest and best agricultural use.

19. Detailed assumptions, cost and benefit estimations, and data sources used in the economic analysis are in Supplementary Appendix D–Detailed Economic Analysis supported by an MS-Excel estimation model (available upon request).

G. Project Costs

20. **Capital Costs.** Total capital costs, based on engineering designs, have been estimated at $96.96 million, which includes a physical contingency of $3.82 million as of June 2016. Duties and taxes were estimated at $8.99 million. All costs were converted into their respective economic values using appropriate conversion factors. In economic terms, the total capital cost amounts to $54.01 million, which is equivalent to PRs 5,657.54 million as of June 2016.

21. **Operation and Maintenance Costs.** The annual incremental O&M cost in financial terms for the irrigation system is PRs 66.09 million, which is equivalent to $0.63 million. Relevant SCF and shadow wage rate factor have been applied to convert the financial O&M costs into their economic equivalence. In economic terms, the annual O&M cost for the irrigation system is PRs 57.98 million (or $0.55 million). The O&M is assumed after hiring the operational staff and would be started from 5th year of the project. Conservatively, the annual real increase in maintenance costs has also been computed at 10% per annum and accounted for in the cash flows

H. Project Benefits

22. **Quantified Benefits.** The chief quantified benefits of the project are the incremental net returns from the production of different crops during the kharif and rabi seasons. These benefits would arise from (i) higher irrigated command area through the provision of full irrigation coverage of the currently rain-fed lands, and (ii) the shifting of crop cultivation from low-value to high-value crops. In addition, the agricultural benefits will also accrue due to improved long-run farm and water management, and availability of reliable irrigation water supply.

23. The net incremental benefits have been estimated at the crop level by developing per hectare crop budgets of all crops under both the without- and with-project scenarios. The intensity at full development has been estimated as 150.6% after the project interventions, which is a significant improvement from the existing cropping intensity of 52.4%.

24. **Unquantified Benefits.** Aside from the improved productivity of irrigated crops arising from the availability of reliable irrigation water supply, additional agricultural benefits may be generated due to the shift in land use from being rain-fed to being fully irrigated. However, the actual pattern of the potential shift is unknown until the project's interventions have been completed and until farmers have completely adapted to such a shift in land use.

I. Economic Analysis and Estimated Results

25. **Approach and Methodology.** A benefit-cost analysis was undertaken to measure the following economic viability criteria: the economic internal rate of return (EIRR) and the economic net present value (ENPV). All costs and benefits have been evaluated in economic terms by converting the financial values by appropriately using the SCF for non-traded goods and export/import parity prices for traded goods.

26. The analysis estimated the net incremental economic benefits attributable to the project by comparing the net economic benefits in the without-project scenario with that of the with-project scenario over the 30-year project life using a 12% discount rate. The net incremental benefits were estimated at crop level for each of the 17 crops considered in the project.

27. **Economic Returns and Sensitivity Analysis.** Construction of the project envisages developing irrigated agriculture in the currently unirrigated, below subsistence farming in the project command area. The socioeconomic condition of beneficiary farming communities will change for the better. It is estimated that with the provision of regulated irrigation due to project interventions, the cropping intensity will increase from 52.4% to 150.6%. In other words, the annual cropped area will increase from 4,573ha to 13,138 ha. Yields for the existing crops are expected to increase from 39% to 123%. The cropping pattern will be diversified with the inclusion of high-value crops which are possible to grow only under regulated irrigation supplies. All these development interventions will enhance productivity and increase farm incomes. Thus, the project is deemed economically viable given the calculated overall economic internal rate of return (EIRR) of 16.1%, and the overall economic net present value (ENPV) of PRs 1,602 million (Table 2). These strong economic results are due to the substantial size of the economic benefit stream relative to the lower cost engineering options for the project cost.

28. The future, however, may not perfectly follow the project assumptions on the engineering cost estimates, agricultural productivity improvements, prices, and the project schedule. It is useful to examine particular project risks and check their effects on the economic viability of the project. The effects of some of these risks on the economic viability of the project are shown in Table 2 and explained subsequently.

Table 2: Results of Economic Analysis and Sensitivity Analysis

Results of Evaluation	Change	ENPV (PRs million)	EIRR	Sensitivity Indicator (SI)	Switching Value (SV)
Base Case		1,602.1	16.1%		
Sensitivity Scenarios					
Case 1 - Increase in Capital Costs	+10%	1,260.6	15.1%	2.13	47%
Case 2 - Increase in O&M Costs	+10%	1,585.8	16.1%	0.10	973%
Case 3 - Combined Case 1 and 2	as above	1,189.0	14.9%	3.47	29%
Case 4 - Decrease in Overall Benefit	-10%	1,028.8	14.7%	5.57	18%
Case 5 - Benefit Delay by 2 years	-2 yrs	354.0	12.8%	n.a	6 yrs
Case 6 - Combination of Cases 3 and 4	as above	615.8	13.5%	n.a	n.a

EIRR = economic internal rate of return; ENPV = economic net present value; SI = sensitivity indicator, the ratio that compares percentage change in ENPV with the percentage change in a variable; SV = switching value, the percentage change in a variable sufficient to reduce ENPV to zero.
Source: ADB estimates

29. **Case 1: Increase in Capital Costs.** To see how vulnerable the economic returns may be to higher construction costs, a 10% increase in capital costs has been considered in the sensitivity analysis. This cost increase causes the EIRR to fall to 15.1%. The level of increase in capital cost, at which the EIRR would be equal to the hurdle rate of 12%, is 47%. **Case 2: Increase in O&M Costs.** A 10% increase in O&M costs will cause no change in the EIRR. The level of increase in total O&M cost at which the EIRR would be equal to the hurdle is 973%. **Case 3: Combination of Cases 1 and 2.** The combination of Cases 1 and 2 will cause the EIRR to fall to 14.9%. **Case 4: Decrease in Overall Benefit.** A 10% decrease in overall benefits will cause the EIRR to fall to 14.7%. The percentage decrease in the overall project benefit at which the EIRR would be equal to the hurdle rate is 18%. **Case 5: Two-year Benefit Delay.** A two-year delay in the realization of project benefits will cause the EIRR to fall to 12.8%. The length of delay at which the EIRR would be equal to the hurdle rate is about 6 years. **Case 6: Combination of Cases 3 and 4.** The combination of Cases 3 and 4 will cause the EIRR to fall to 13.5%.

30. The sensitivity analysis indicates that the economic viability of the project is most sensitive to the two-year delay in the realization of benefits. Therefore, it is essential that the project is implemented as scheduled through the provision of technical and extension support to the project beneficiaries. It is also important that system maintenance be carried out as proposed in the project's Operation and Maintenance Requirements and Sustainability Plan to ensure that the benefits can materialize as estimated during the expected period.

J. Project Benefit Distribution and Poverty Impact

31. **Household Financial Returns.** From the perspective of farm households, the incremental irrigated area would generate an average annual benefit of around $1,897 per ha due to project investments in irrigation. With an average farm size of 1.01 ha[9] in the command areas and average rural family size of six people,[10] a farm household is expected to get an income increase of about $1,744 per annum, whereas per capita income in the project beneficiary household will increase by about $291 per annum.

32. **Distribution of Project Benefits and Poverty Impact.** The distribution of economic benefits and costs over and above financial revenues and expenses are estimated to determine the extent to which public investment policy can affect the share that the various sectors derive from the project. Table 3 presents the result of the benefit distribution analysis. The project poverty impact ratio is estimated at 88.7% as outlined in Table 4.

Table 3: Distribution of Economic Benefits
(PRs million)

	Financial Present Value	Economic Present Value	Economic less Financial	Distribution of Project Benefits			
Description				**Government**	**Economy**	**Labor**	**Farmers**
Total Benefits	34.8	5,732.6	5,697.8				5,697.8
Project Costs							
Traded	2,352.4	1,236.1	(1,116.3)		1,116.3		
Skilled labor	1,021.9	537.0	(484.9)			484.9	
Unskilled labor	1,650.7	867.4	(783.3)			783.3	
Non-traded	2,835.6	1,490.0	(1,345.5)		1,345.5		
Total Project Costs	**7,860.6**	**4,130.5**	**(3,730.0)**				
Net Benefits	**(7,825.8)**	**1,602.1**	**9,427.9**	**(7,825.8)**			
	Gains/Losses			**(7,825.8)**	**2,461.8**	**1,268.2**	**5,697.8**

Source: ADB Estimates.

[9] Census of Agriculture (2010). Pakistan Census Organization. [please provide a complete reference in the correct format]
[10] Pakistan Bureau of Statistics (2008). [please provide a complete reference in the correct format]

Table 4: Poverty Impact Analysis
(PRs million)

Particulars	Gov/Economy[a]	Labor[b]	Farmers[c]	Total
Benefits (Losses)	2,461.8	1,268.2	5,697.8	9,427.9
Financial Return to Government	(7,825.8)			(7,825.8)
Total Benefits (Losses)	(5,364.0)	1,268.2	5,697.8	1,602.1
Proportion of the Poor (%)*	22.3%	75.17%	29.2%	
Benefits to Poor	(1,196.2)	953.3	1,663.8	1,420.9
Poverty Impact Ratio (%)				88.7%

Source: ADB Estimates.

[a] (Gov/Economy); World Bank. 2014. *World Development Indicators.http://data.worldbank.org/data-catalog/world-development-indicators*

[b] (Labor): NASIR, Z.M. 2001. *Poverty and Labor Market Linkages in Pakistan, Micro Impact of Macroeconomic Adjustment Policies (MIMAP) Technical Paper Series No. 7*, Pakistan Institute of Development Economics, Islamabad, Pakistan.

[c] (Farmers): United National Development Programme. 2011. *Khyber Pakhtunkhwa Millennium Development Goals*. Peshawar.