ECONOMIC EFFECTS OF TARBELA MISHAP

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1. Introduction

One of the most important national objectives to be achieved by Pakistan is the increase in the agricultural production both of foodgrains and cash crops. The increase in foodgrains specially wheat would enable conservation of vast amount of foreign exchange which is currently being spent on their imports for meeting the national requirements. The increase in the production of cash crops is also necessary for earning foreign exchange through exports of such items either in raw, processed or manufactured form. Considering the availability of the cultivable land this national objective is considered feasible and can be achieved, on the one hand, by increasing the cropped area either by bringing more land under cultivation or by raising the intensity of cropping and, on the other hand, this can be accomplished by increasing the yield per acre through the use of modern inputs and improved technology. However, the greatest constraint in realizing this objective is on account of water input. It is the scarcity of dependable and timely water supplies that, as a limiting factor compared to the available land, led over a period of time to the problem of salinity which, in conjuction with the conditions of water logging, created due to ineffective drainage facilities in the irrigated area, has played havoc with the agricultural production from the available land resources of the country. The genesis and the cure for these maladies are now fully known and need not be described here. However, it is a recognized fact that availability of adequate amount of surface water for irrigation purposes with efficient drainage system is perhaps the most important element in water resource development for achieving the national objectives stated above. It was in recognition of this fact that Tarbela Dam Project was planned and constructed.

2. The Project and the Mishap

Tarbela Dam as a multipurpose structure was designed to provide a live storage capacity of 8.6 M.A.F. witb a draw down level of 1332 feet commensurate with electricity generation requirement. The project was intended to start impounding water with a restricted retention level towards the end of the flood season 1974 so that a limited amount of storage might be available for the release period 1974-75. Impounding to top water level (1550 ft above MSL) was scheduled for 1975 with full use of storage during the release period 1975-76. Accordingly the impounding of the reservoir started early July, 1974 and by July, 27 with careful gates operation regulation the water level rose to 1463 ft. However, on July, 24 when tunnel 1 was completely closed for the first time there was threat to the second of the cofferdam cell (the first had already collapsed after full closure of all the three gates of tunnel 2 on July, 15) and closure of the centre gate of the tunnel 2 was attempted but it could not move upto the full closing distance and had to be re-opened. Subsequent efforts to close the gate were not successful and gates on tunnel 3 and 4 were partly opened on August, 7 to stop further reservoir rise although damages to the downstream drainage required that the gate openings be reduced. On August, 13 the steel liner in one of outlet passage of tunnel 3 failed and tunnels 3 and 4 were again closed off. Extensive damage to the liners in both tunnels and cavitation of the concrete chutes occurred. On August, 15 centre gate of tunnel 2 was fully opened but immediately stones appeared downstream. The gate was returned to the partly closed position where again it stuck and the following day a side gate of tunnel 1 also jammed when partly closed. Subsequently on August 21 the discharge from tunnel 2 shot up by four times and about 196 ft length of the tunnel gave way with the result that the water began to wash away the hill-side. The immediate emergency lowering of water level was resorted to which caused a substantial jump in down-stream releases and damages to cofferdam. The overall result was that a vast chunk of dam's abutment was washed through a 196 ft long hole in tunnel 2 and about 33 ft hole below the foundation level of intakes 1 and 2.

It is not intended to go into the causes and further details of

the factors which resulted in the mishap. Suffice to say that the target filling of the reservoir during 1974 could not be achieved and the stored water had to be drained out immediately to empty the reservoir for carrying out necessary repairs. Obviously this had adverse repercussion on the economy of the country inasmuch as all the expected benefits associated with the utilization of the contemplated stored water of 6.2 M.A.F. had to be foregone.

3. Identification of economic effects.

The most notable result of the mishap was that the increase in the agricultural production, which could have been obtained from the use of the stored water released from the reservoir from January to May, 1975 and again during November and December, 1975 was lost. Against the planned availability of water of 8.6 M.A.F. from November 1975, to May 1976, less than 6.2 M.A.F. are expected to be available from January to May 1976, resulting in the loss of associated benefits. Secondly, the savings in the import bill of wheat to be achieved to the extent that the increased wheat production could have been obtained by the use of the stored water reducing the need of wheat imports had to be foregone. This loss of import substitution opportunity eliminated a factor which could have lessened the strain on country's balance of payment. Thirdly, due to the mishap availability of power from the dam had to be deferred by one year. This resulted in the loss of power much needed particularly by the growing industrial and agricultural sectors. Fourthly, the mishap necessitated heavy expenditure on the repairs of the damaged works. Certainly with no mishap the amount involved could have been used for more productive purposes in various sectors of the economy.

That the mishap resulted in great loss to the economy is generally recognized. However, very little information on quantitative assessment of the loss involved on some realistic basis is forthcoming. In this paper an attempt has been made to evaluate the effect of the Tarbela mishap on the economy as identified above measured in monetary terms. It is, however, necessary to hasten to state that since the Tarbela Dam multipurpose project occupies a pivotal position in the economic development of the country, by providing very important inputs to such basic sectors as agriculture and industry, it is recognized

that the entire economic super-structure of the country became studded with the effects of the mishap in a very complicated and complex way through sectoral interrelations and inter-dependencies. The evaluation presented in this paper is confined to the measurement of the effects of the mishap in respect of the sectors of the economy directly effected by the mishap.

4. Measurement of economic effects.

4.1 *Agricultural Production.*

Methodology:

From the point of view of agriculture the area of interest for this study is the Tarbela Command. It covers a gross area of 24.68 million acres and a cultivable commanded area of 21.81 million acres. The area is commanded by Pehur, Pharpur, Thal, Haveli, Sutlej valley, Panjnad, Taunsa, Guddu, Sukkur and Kotri canal systems. The area of districts Mianwali, Muzaffargarh, Lyallpur, Jhang, Multan and Bahawalpur, Rahimyarkhan, Bahawalnagar and almost the entire Sind province fell within the Tarbela Command.

It may, however, be added that because of its location on the upper Indus and the construction of transbasin link canals under the Indus Basin Project it is physically possible to use Tarbela water on all the existing projects fed from Indu downstream of Tarbela. The releases could be served directly to any parts of the Indus Basin South and South West of the line formed by the Chashma-Jhelum link and the T.S. and S.M.B. links. Because of the interchangeability of surface water supplies during the Rabi season throughout most of the canal systems Tarbela water would add to the overall availability in the system at times and in places of most stringent scarcities. Canal capacities generally would not present difficulty in the short run to the use of additional Rabi water supplies. Therefore, in this study it has been assumed that the entire Tarbela command would have possibly made use of the available supplies for increased agricultural production.

It is assumed that so far as agricultural production is concerned the impact of the mishap would be concentrated in the entire Tarbela command as explained above. Such effects have been measured by comparing the situations in respect of crop

production under the 'With' and without Tarbela Water. Throughout average conditions have been assumed and all factors have been taken to apply to the command on average basis. From the average cropping pattern in the command based on five years figures the crops effected by the mishap were identified on the basis of calender and water requirements. The existing water availability in the command based on the average of five year canal withdrawals in the relevant months utilized by these crops was examined. An estimate of the depression in yields from these crops on account of water constraint that could have been reduced by the availability of Tarbela water release was made. Net Production Values (NPV) per acre of the different crops under the 'With' and "without" Tarbela water conditions were calculated and the difference between the two values was taken as a measure of the incremental benefits of the Tarbela which, as a matter of fact had to be foregone due to the mishap. From the incremental benefits, the value of per acre foot of Tarbela water was determined. This was used to evaluate more benefits foregone as a result of the non availability of Tarbela water in November and December 1975 and lesser than planned water from January to May 1976.

Crops and Cropping Pattern:

Table I shows the crops and the cropping pattern in the Tarbela command as worked out on basis of the average crop acreages for the period 1968-69 to 1972-73. This indicates that the crops relevant in context of the additional water from Tarbela during the period from January to May 1975 are Wheat, Rabi Pulses, Rabi Fodder, Oilseeds, Sugarcane, Cotton, Orchards and Kharif fodder.

Table 2 shows the average monthly canal withdrawals for use in the command. An examination of tables I and 2 indicates that the availability of water in the command was much below the crop requirement with adverse effect on the yields of the crop sown. Table 3 shows the availability of water in the command 'with and without' Tarbela supplies. The availability of Tarbela water during the months January to May by providing additional irrigations would have reduced the depression in yields to some extent.

Availability of Additional Water:

As already stated if the mishap had not happened, an additional water of 6.2 M.A.F. would have become available for

TABLE I

Tarbela Command
Crop Area and Cropping Pattern
(Average 1968-69—1972-73)

—Million Acres

Crops	Acreages	Crop area Percent
Kharif		
Rice	1.661	11.6
Maize	0.142	1.0
Bajra	0.353	2.5
Pulses	0.099	0.7
Oilseeds	0.059	0.4
Fodders	1.337	9.4
Vegetables	0.044	0.3
Cotton	2.247	15.8
Others	0.417	2.9
Kharif Total	6.359	44.6
Rabi		
Wheat	4.068	28.6
Grams	0.606	4.2
Pulses	0.670	4.7
Oilseeds	0.615	4.3
Fodders	1.127	7.9
Vegetables	0.075	0.5
Others	0.118	0.8
Rabi Total	7.279	51.0
Perennial		
Sugarcane	0.431	3.0
Orchards	0.201	1.4
Total	0.632	4.4
Grand Total	14.270	100.0

Source: Water Management, I.B.P. WAPDA –Tarbela Dam Project Monitoring Irrigation and Agricultural Data.

use in the command. Assuming the release pattern as given in Project Planning Report the availability of additonal water during the various months would have been as given in Table 4.

TABLE 4

ADDITIONAL WATER AVAILABILITY
(At Dam site)
(WITH NO MISHAP)

MAF

	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
1974-75	—	—	1.70	2.00	1.50	0.70	0.30	6.20
1975-76	0.79	0.95	1.80	2.14	1.63	0.86	0.43	8.60

TABLE 2

Tarbela Command

Canal Withdrawals

— Million Acre feet—

Month	Tarbela Command
KHARIF	
April	2.96
May	4.68
June	8.71
July	9.94
August	8.85
September	8.16
Kharif Total	43.30
RABI	
October	5.01
November	3.26
December	2.39
January	2.03
February	2.12
March	2.30
Rabi Total	17.11
Grand Total	60.41

Source:—Water Management Cell, I. B. P. WAPDA—Tarbela Dam Project Monitoring Irrigation and Agricultural Data.

TABLE 3

TARBELA COMMAND
Water Requirement and Availability
(January to May)

—M. A. F.—

Month	Water requirement (at field head)	Canal Water availability (at field head)	Surplus (+) Deficit (−)	Availability as percent of requirement	Supplies from Tarbela (at field head)	Total canal water availability (inclusive of Tarbela) (3+6)	Surplus (+)/ Deficit (−) (inclusive of Tarbela)	Availability of requirement with Tarbela col. 7 as percent of col. 2	Surplus (+)/ Deficit (−) with Tarbela
1	2	3	4	5	6	7	8	9	10
January	1.78	1.42	−0.36	80	1.02	2.44	+0.66	137	+37
February	2.00	1.27	−0.73	64	1.20	2.47	+0.47	124	+24
March	2.34	1.39	−0.95	59	0.90	2.29	−0.05	98	− 2
April	2.28	1.77	−0.51	78	0.42	2.19	−0.09	96	− 4
May	3.36	2.81	−0.55	84	0.18	2.99	−0.37	89	−11

Effect on Crop Yields:

Considering the water requirement of the crops concerned at various stages of their growth and the data given in table 3 the effect of the availability of the addi tional water from Tarbela during the month as shown in table 4 was worked out. It is estimated that due to the availability of additional water in the various months compared to the existing availabilities there could have been an improvement in yields to the extent of 10 percent in sugarcane and Kharif fodder, 20 percent in Wheat, Orchards and other Rabi crops. It is also estimated that about 5 percent improvement in Cotton yield could be achieved as a result of availability of water in early Kharif period.

Incremental Net Production Values :

Tables 5 and 6 show the calculation of the Net Production Values (NPV) per acre of the crops concerned under the condition of ,'With'' and Without'' additional water from Tarbela. The NPV for each crop has been worked out by deducting from the Gross Production Values (GPV) the associated farm costs. The (GPV) is obtained by multiplying the crop yield with the farm gate prices which are exclusive of transportation costs. The associated farm costs include those on fertilizer, pesticides, water charges, hired labour and other costs covering the farm overheads. The difference between the NPV under the two conditions indicates the incremental benefits from the Tarbela water that could not be realised due to the mishap.

TABLE 5
CALCULATION OF NET PRODUCTION VALUE FROM AGRICULTURE WITHOUT TARBELA WATER

Crops	Yield Maunds/ Acre	Farmgate Prices Rs./ Maund	Gross Production Value (Rs.)	PRODUCTION EXPENSES							Net Production value (Rs.)
				Seed	Fertilizer	Water	Pesti-cides	Labour	Others	Total	
Wheat	15·4	33·00	508·20	21·00	75·00	10·14	...	69·00	17·51	192·65	315·55
Rabi Pulses	4·7	90·00	423·00	32·00	37·50	7·60	...	25·00	10·21	112·31	310·69
Rabi Fodders	342·0	2·00	684·00	29·60	37·50	5·40	12·00	22·00	10·65	117·15	566·85
Rabi Oilseeds	5·3	65·00	344·50	16·90	37·50	8·80	17·30	16·50	9·70	106·70	237·80
Sugarcane	402·0	4·50	1809·00	360·00	109·20	31·06	45·00	80·00	62·53	687·79	1121·21
Seed Cotton	12·4	80·00	992·00	20·00	75·00	16·00	80·00	52·00	24·30	267·30	724·70
Orchards	...	3000·00*	3000·00	...	75·00	25·60	60·00	62·00	22·26	244·86	2755·14
Kharif Fodders	257·5	2·00	515·00	17·80	19·80	7·80	...	22·00	6·74	74·14	440·86

*Rs./Acre

TABLE 6
CALCULATION OF NET PRODUCTION VALUE FROM AGRICULTURE WITH TARBELA WATER

Crops	Yield Maunds/ Acre	Farmgate Prices Rs./ Maund	Gross Production Value (Rs.)	PRODUCTION EXPENSES							Net Production Value (Rs)
				Seed	Fertilizer	Water	Pesti-cides	Labour	Others	Total	
Wheat	18·5	33·00	610·50	21·00	75·00	10·14	...	82·89	18·90	207·93	402·57
Rabi Pulses	5·6	90·00	504·00	32·00	37·50	7·60	...	29·78	10·69	117·57	386·43
Rabi Fodders	410·0	2·00	810·00	29·60	37·50	5·40	12·00	26·37	11·09	121·96	688·04
Rabi Oil seeds	6·4	65·00	416·00	16·90	37·50	8·80	17·30	19·92	10·04	110·46	305·54
Sugarcane	442·0	4·50	1989·00	360·00	109·20	31·06	45·00	87·96	63·32	696·54	1292·46
Seed Cotton	13·0	80·00	1040·00	20·00	75·00	16·00	80·00	54·52	24·55	270·07	769·93
Orchards	...	3600·00*	3600·00	...	75·00	25·60	60·00	74·40	23·50	258·50	3341·50
Kharif Fodders	309·0	2·00	618·00	17·80	19·80	7·80	...	26·40	7·18	78·98	539·02

*Rs./Acre

Table 7 shows the total value of the agricultural production effected due to the mishap.

It may be added that, as shown in table 4, had the mishap not happened 8.6 M.A.F. of water would have become available from November, 1975 to May 1976 as per release pattern shown in the table. However, due to mishap it is assumed on the basis of available information that Tarbela release could be raised to a maximum level of 1550 during 1975-76. Therefore, the water volume between the said level of 1550 and the maximum pool level of 1565 will not be available for use during 1975-76. This involves a loss of about 2.4 M.A.F. during the year 1975-76, Assuming Rs. 162 as value per acre foot of incremental water as previously worked out, this entails a loss of Rs. 388.8. million during the year 1975-76. Thus the cumulative loss due to the mishap in the form of effect on the agricultural production works out Rs. 1396.3 milllon.

4.2 **Impact on Wheat imports.**

It is estimated that had the mishap not happened additional 0.463 million tons of wheat could have been obtained in 1974-75 from higher yield resulting from use of Tarbela water thereby reducing the need of import of wheat by about 58 percent. In monetary terms the import bill on account of wheat would have been reduced by Rs. 1016.74 million ($104.2 million). Similarly, with water supplies from Tarbela an additional area of 0.9184 million acres of wheat could have heen sown during 1975-76. From this additional area 0.624 million tons of wheat valuing Rs. 1096.68 million ($112.36 million) could have been obtained thus reducing the projected import of 1.5 million tons by about 42 percent.

On the basis of the above estimates it is seen that Tarbela mishap resulted in a cost of Rs. 1113.42 million ($216.5 million) to the economy in respect of import of wheat.

4.3 **Effect of power Foregone.**

The damage caused to the tunnels resulted in the delay in

the commissioning of the Tarbela Power Station. The original as well as the revised schedules are give below:

Unit No.	Installed Capacity (M.W.)	Original schedule	Revised schedule
1	175	October 1975	October 1976
2	175	January 1976	December 1976
3	175	March 1976	March 1977
4	175	May 1976	May 1977

TABLE 7

Incremental value of Agricultural Production due to mishap (1974-75)

Million Rs.

Crops	N.P.V. with Tarbela Water	N.P.V. Without Tarbela Water	Incremental Benefits Foregone
Wheat	1667.65	1283.66	353.99
Rabi Pulses	258.91	208.16	50.75
Rabi Fodders	775.42	638.84	136.58
Rabi Oilseeds	187.91	146.25	41.66
Sugarcane	557.05	483.24	73.81
Cotton	1730.03	1628.40	101.63
Orchards	671.64	553.78	117.86
Kharif Fodders	720.67	589.43	131.24
Overall	6539.28	5531.76	1007.52

Incremental Value Foregone per acre foot of water = Rs. 162

The total monthly generation during an average year from the first four units planned to be installed at Tarbela is estimated as given in Table 8. This energy generation capability has been worked out under the average rule curve and 50 percent frequency in flow conditons. Since the average annual load factor in case of Tarbela is assumed to be 70 percent by WAPDA, the table also gives the energy generation at this rate along with that at the unity load factor.

TABLE 8

Estimated power Generation at Tarbela

Million KWH

Months	At unity load Factor	At load Factor of 70 percent
July	401	280
August	579	405
September	567	396
October	538	376
November	495	346
December	481	336
January	441	308
February	365	255
March	346	242
April	346	242
May	224	159
June	188	131
Total	4896	3420

From the above table it can be seen that at 70 percent load factor 3420 million units could be generated in a year. Allowing for the generation, transportation and distribution losses at 25 percent, the net units available for sale but lost due to mishap work out as 2565 million. Evaluated at an average rate of Rs. 0.23 per KWH the total loss to the economy from one year's delay in power installation due to the mishap is estimated to be Rs. 589.95 million as per break up given below;

Years	Power Production Foregone (million KWHs)	Value (Million Rs)
1975-76	868	199.64
1976-77	1697	390.31
Total	2565	589.95

4. 4. Cost of Repairs

Due to the mishap Tunnel 1 and 2 were severely damaged during the filling of the reservoir. To repair the damage to the tunnels and to make all project features operable and safe for the next flood season it was necessary to take immediate steps. As such a meeting of special consultants was held from September 27 to October 4, 1974 in which the eminent engineers of the country as well as from the World over took part to explore the causes of this failure and to recommend ways and means to overcome it. On the basis of the recommendation of this special committee the repair work was started. Modifications in designs of certain works were also recommended to ensure further safety. This resulted in additional work involving an estimated expenditure of Rs. 621.87 million as per break up given below :

	Million Rs.
Repair and Restoration	300.43
Additional Works	264.91
Contingencies at 10 percent	56.53
Total	621.87

Thus as a result of mishap the economy had to bear a financial burden of the order of Rs. 621.87 million. This had the economic effect of foregoing the investment opportunities in the economy to this extent for alternative productive purposes.

5. Summary of Results

On the basis of the analysis presented in the preceeding sections the total loss to the economy on account of the Tarbela mishap discussed in the paper is estimated as summarized below :—

	Million Rs.			
	1974-75	1975-76	1976-77	Totat
Agricultural Production	1007.5	388.8	—	1396.3
Imports of wheat	1016.7	1096.7	—	2113.4
Power	—	199.6	390.3	589.9
Cost of Repairs.	621.9	—	—	621.9
Total	2646.1	1685.1	390.3	4721.5

6. Impact on Economic Growth

During the year 1974-75 the economy of Pakistan has been subject to great strain and stress. The impact of the world economic crisis characterised by inflation accompanied by a recession caused decline in terms of trade to such an extent that Pakistan was classified as one of the Most Seriously Affected (MSA) countries by the United Nation. The strain on the economy due to this impact of world economic situation was exacerbated by a serious water shortage in the existing irrigation system due to the occurance of the lowest flows of the three major rivers ever recorded. At the top of it the strain on the economy was reinforced by the Tarbela mishap. The impact of all these factors was that the increase in Gross Domestic Product (GDP) at constant prices (1959-60), which may

be taken as a measure not economic growth, was 2.6 percent during 1974-75. Such a low rate of growth could be achieved inspite of a number of hard decisions taken by the Government to protect the economy and improve its long term prospects. The contribution of agriculture, one of the most leading sector of the economy, to GDP registered a decline by 2 percent.

The impact of Tarbela mishap in causing such a dismal situation of economic growth can be best measured by estimating the rate which could have been achieved had the mishap not happened. The analysis presented in this paper indicates that with the use of the Tarbela stored water the contribution of the agriculture sector to GDP in 1974-75 would have been of the order of Rs. 1007.5 million which when brought on constant price basis, using the National Income Deflator of 22.5 percent, works out Rs. 780.83 million. With this contribution total GDP of Pakistan in 1974-75 would have been Rs. 3843.8 million against Rs. 374.62 million actually achieved. Compared to GDP of Rs. 36521 million in 1973-74 the rate of economic growth of 4.2 percent which could have been achieved with no Tarbela mishap is just a little less than the long term trend growth in the economy. If the effect on the current account of the blance of payment from the reduction in the import bill by Rs. 1016.7 million due to the increased production of wheat with the use of Tarbela water is also taken into account it can safely be said that if the mishap had not happened, inspite of the strain on the economy due to other causes, the long term trend of economic growth could have been achieved. The impact of the Tarbela mishap on the economic growth of the country during 1974-75 is, therefore, obvious.

7. Conclusion

The evaluation presented in this paper clearly indicates that the economic effects of the Tarbela mishap in terms of the benefits to the economy foregone and the amount involved for the repairs of the works had very damaging influence on the economy of the country. It resulted in great set back to the

programme of achieving self sufficiency in wheat. A potential source for bringing improvement in the difficult position of balance of payment was lost. Due to delay in commissioning of power plants by one year, in addition to loss of revenue from power, the value added from the agricultural and industrial sectors due to the use of the power that could have been generated had to be foregone. In view of the enormity of the resources lost, particularly in the context of the present unhealthy economic situation due to the national and international factors, the mishap can rightly be described as a hard challenge in magnitude of a calamity fallen on the nation.