Paper 2: Performance Measure Study

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BACKGROUND

In view of a growing population and an increasing pressure on natural resources like land and water to produce the necessary food, good performance of the irrigation sector has growing importance. Over the last decades His Majesty's Government of Nepal (HMG), supported by foreign donors, invested substantially not only in the expansion of area under irrigation but also in modernization of the existing irrigation infrastructure. For example, the Irrigation Management Transfer Project is designed to rehabilitate irrigation systems and thereafter turn over the management to the users' groups. It is expected that this will lead to higher agricultural production and lower expenses for the government. A proper performance assessment is an essential part of such efforts in order to evaluate achievements and recommend refinements in future programs. In Nepal, this important task is the responsibility of the Research and Technology Development Branch (RTDB) under the Department of Irrigation. The International Water Management Institute (IWMI) is providing support in improving the M&E data collection and analyzing the collected data. This report deals with the methodology and results of a comparative performance study conducted by IWMI in collaboration with RTDB from January till April 1998.

Performance Assessment

In Nepal performance assessment is often done on a single project basis. Usually, the consultant responsible for the execution of the project reports on the achievements and benefits of the program. Every program has it own objectives and uses its own measures to evaluate the degree in which the objectives were met. For this reason, a comparison between systems to obtain an overview of general trends in irrigation performance is difficult. In this study, the same indicators were applied to seven schemes in the Terai over a time span of 5 years[7]. A comparison between systems (spatial) and the development of performance over time (temporal) was accomplished. The main questions to be answered by this comparative performance assessment study are:

- What are the trends in performance of irrigated agriculture?
- What are the impacts of Management Transfer on irrigation performance?

To answer these questions the selection of the appropriate indicators to measure performance is essential. Over the last decade numerous performance indicators have

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[7] A longer time span (f.e. 10 years) is preferable to reveal trends, but data were not available.

been developed and tested. A literature overview given by Rao (1993) gives some 50 indicators, mainly in the field of irrigation water management. One of the difficulties in using those indicators is related to the data requirement. For most indicators detailed information on canal flows at different locations (head, middle and tail) in the scheme is needed. Very often these data are not readily available and must be measured exclusively for the purpose of computing the indicators. This is labor intensive and hence expensive, especially if longer time series are required and/or more than one schemes are involved in the study.

METHODOLOGY

IWMI's Set of Standard Performance Indicators

IWMI identified a set of standard performance indicators that were tested in several countries (Perry 1996, Molden et. al. 1998). The main indicators measure the major outputs (agricultural production) against the major inputs of land and water. Additional indicators reflect key features of water control and financial management. The set proved a valuable tool for comparative irrigation performance evaluation and intervention impact assessment. A great advantage of the set is the limited data requirements. The indicators can be computed with basic data on agricultural production, water use and financial management. These data are generally available from secondary sources.

A review of the existing M&E system used in the Department of Irrigation (Neupane 1997) revealed that data collection and analysis in Nepal's irrigation sector is still far from perfect. However, in most schemes currently under a management transfer program the basic data on agriculture, water use and financial management are documented on a more or less regular basis.

Description of Comparative Indicators

For this study the main performance indicators reflecting land and water productivity were taken from IWMI's set. The additional indicators deviate slightly from the IWMI set to suit the objectives of this study, taking into account the local circumstances. The indicators used in this study are listed in the textbox below. A detailed description and explanation of each indicator is given with Paper 1.

Textbox 2.1: indicators used in the study

Basic Indicators

1. Gross Value of Production per hectare of the command area
2. Gross Value of Production per hectare of the irrigated area
3. Gross Value of Production per unit of irrigation supplied
4. Gross Value of Production per unit of water consumed by ET_{crop}

Additional Measures

Water management

5. Relative Water Supply
6. Relative Irrigation Supply

Financial management

7. Fee collection efficiency
8. Financial Self-Sufficiency
9. O & M expenditures per unit of land and water

Data Requirements and Collection

Basic data on climate, crops, water use and financial management are needed to compute the indicators and accomplish a comparative study. The major parts of the data were collected from secondary sources in Kathmandu. The climate data were collected from the Department of Meteorology. Local prices of main agricultural products were obtained from the Department of Agriculture. Data on agriculture, water use and financial management were available in the Department of Irrigation and compiled by IWMI in collaboration with the RTDB. A field trip was made to all 7 schemes to fill some data gaps and check the consistency of data. Where available, WUA's records were used prior to central level data as they are considered to be more reliable.

Usually, those who are also responsible for the execution of the project collect the data. In some cases this might lead to a bias to show progress. Especially areas tend to be over-estimated. For example in Panchakanya the area cultivated with paddy was reported as 600 ha, while WUA only showed 442 ha. The same for Khageri where the project reported 3900 ha, while farmer records only showed 2380 ha. Another problem arises due to the inconsistencies and discrepancies in reporting by different agencies or institutes. For example, data kept on central level by the Dept. of Irrigation might differ from data reported by the local consultant working in the project.

The Selected Schemes

The indicators were applied to 7 schemes located in the Southern plain of Nepal. The monthly temperature varies from 6 to 37 °C. The rainfall averages from 1300 to 1900 mm annually of which 80 to 90 % falls in the monsoon from June - September. The schemes were selected on the basis of time series data availability. Furthermore, in all schemes efforts to transfer management, fully or partly, to WUAs are being undertaken or recently completed. Five out of the seven schemes are run-of the-river systems while one-scheme pumps water from the river and one scheme gets groundwater using deep tube wells.

The selected schemes and their salient features are summarized in table 2.1. Table 2.2 provides details on climate.

Table 2.1: Salient Features of Selected Schemes

Name	Size (ha)	Type of scheme	Management Transfer
West Gandak	10,300	Run of the River	Jointly managed since 1992, fully transferred in September 1997 under the IMTP
Panchakanya	600	Run of the River	Fully transferred in November 1997 under the IMTP
Khageri	3,900	Run of the River	Jointly managed
Kankai	7,000	Run of the River	Jointly managed
Sunsari Morang	16,550*	Run of the River	Jointly managed
Marchwar Lift	2,815	Pump from River	Fully transferred in February 1998
Bhairawa Lumbini Ground Water	7,200**	Groundwater, deep tube wells	Stage I consist of 65 tube wells. Some have been fully transferred, others still are in turnover process.

* only phase II area taken into analysis ** only stage I tube wells

Table 2.2: Climate Data, Long Term Averages

Bhairawa Airport

Altitude: 109 Meters above sea level
Latitude: 27.13 Deg. North
Longitude: 83.27 Deg. East

Month	MaxTemp (deg.C)	Min.Temp (deg.C)	ETo (mm/d)	Total rain (mm)
January	22.2	6.3	2.10	10
February	24.7	9.6	3.02	0
March	31.2	13.6	4.56	6
April	36.2	19.7	6.35	7
May	36.6	23.4	6.66	35
June	34.6	24.0	5.05	214
July	32.5	25.0	4.58	393
August	32.5	25.1	4.28	367
September	31.6	23.8	3.72	218
October	31.0	20.7	3.58	61
November	28.2	13.3	2.68	0
December	23.4	8.1	1.98	0
Annual	***30.4***	***17.7***	***1478***	***1311***

Biratnagar

Altitude: 72m. above sea level
Latitude: 26.29 Deg. North
Longitude: 87.16 Deg. East

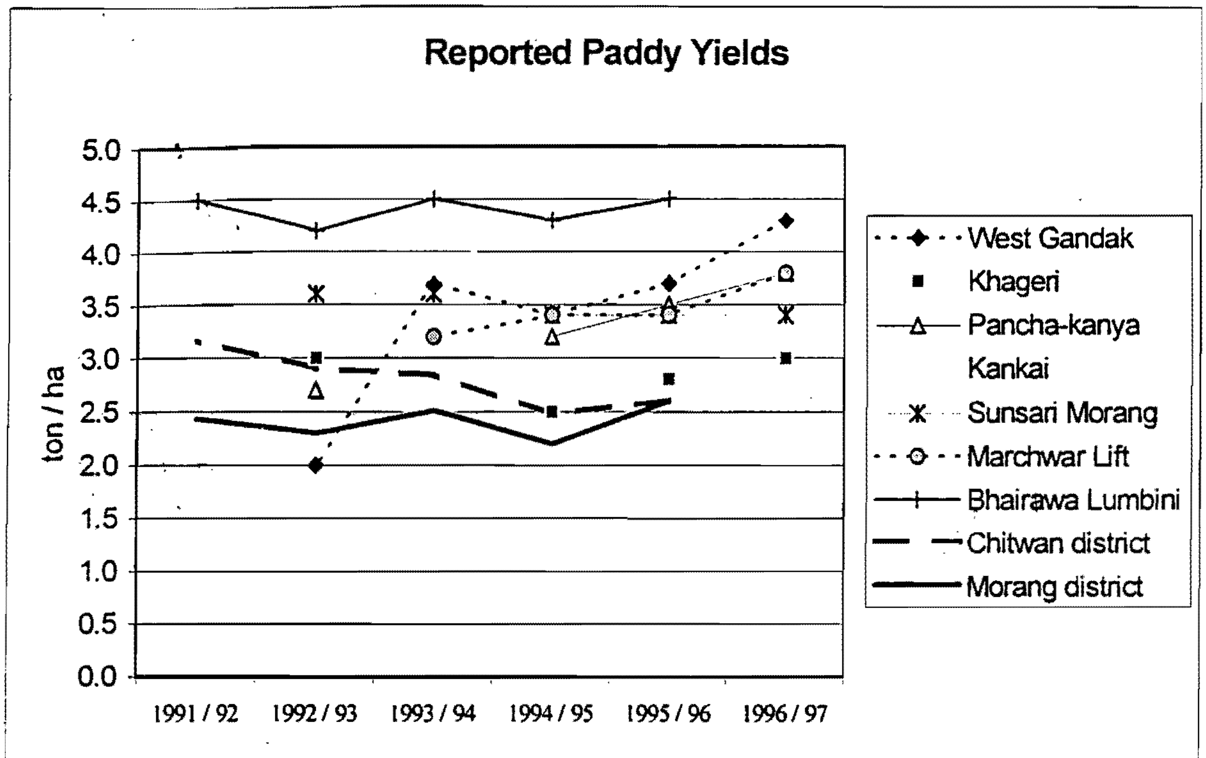
Month	MaxTemp (deg.C)	Min.Temp (deg.C)	ETo (mm/d)	Total rain (mm)
January	23.3	8.6	2.20	21
February	25.8	10.2	3.04	7
March	31.4	14.9	4.50	12
April	33.8	20.5	5.64	41
May	32.9	22.6	5.33	118
June	32.4	24.9	4.61	336
July	31.6	24.0	4.05	473
August	31.9	24.0	3.93	388
September	31.0	23.0	3.53	394
October	31.1	20.1	3.42	103
November	28.6	14.1	2.66	4
December	24.9	9.0	2.01	0
Annual	***29.9***	***18***	***1365***	***1897***

RESULTS

Gross Value of Production per Hectare of the Command Area

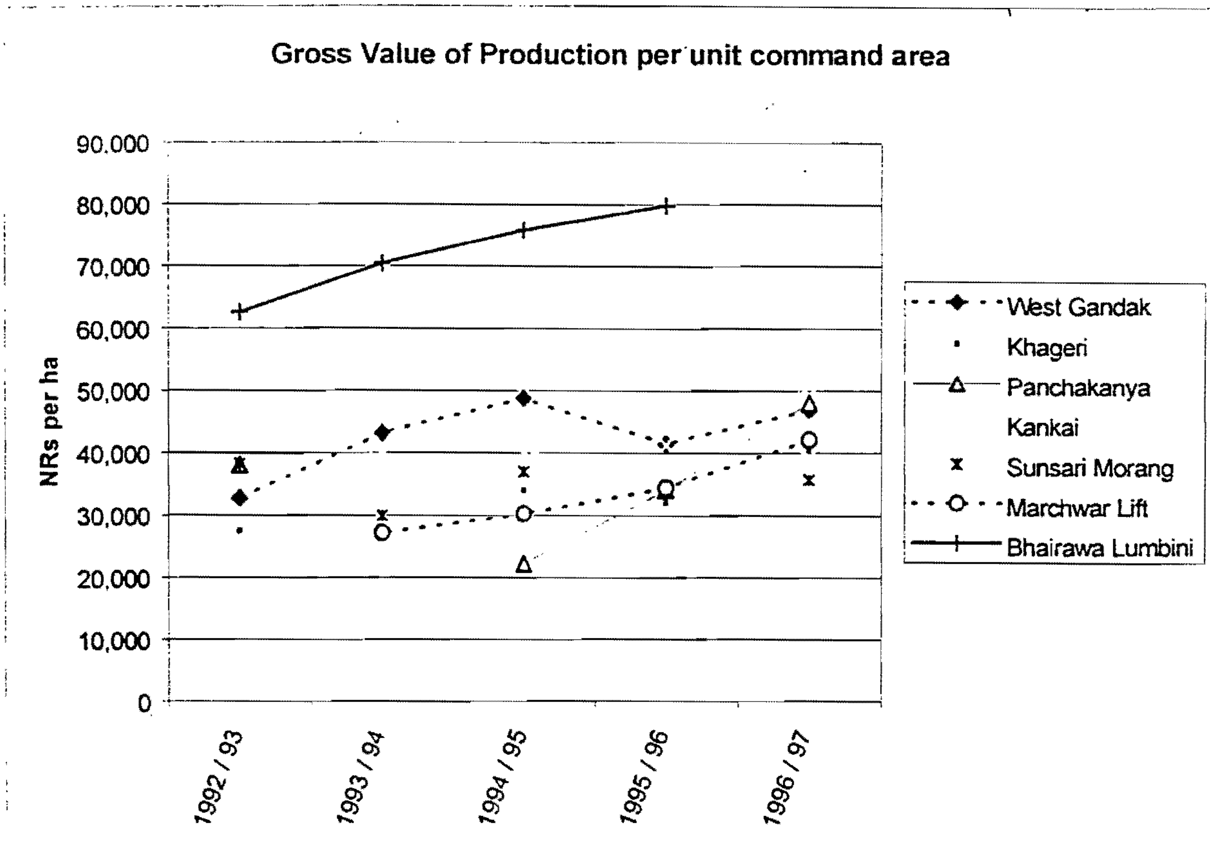
The Gross Value of Production (GVP) per unit of the command area reflects the land productivity taking into account the whole scheme. Its values depend on crop choice, yields and prices, and also on the cropping intensity.

Graph 2.1: Reported Paddy Yields in ton per ha, Compared to Overall District Yields



Graph 2.1 displays the reported paddy yields in the 7 selected schemes over the last 5 years. To relate those values to general developments in agriculture in Nepal the overall values for 2 districts in West and Eastern Nepal are included. Generally, the yields in the 7 schemes are slightly increasing or remain more or less on the same level, while the district values are slightly declining (Mid Nepal) or remain at the same level (Eastern Nepal). Compared to the overall developments, paddy yields in the schemes are improving, probably due to recent efforts of rehabilitation, which in most schemes are still ongoing.

Graph 2.2: Gross value of Production per unit irrigated area (All prices mentioned in 1995 constant rupees)



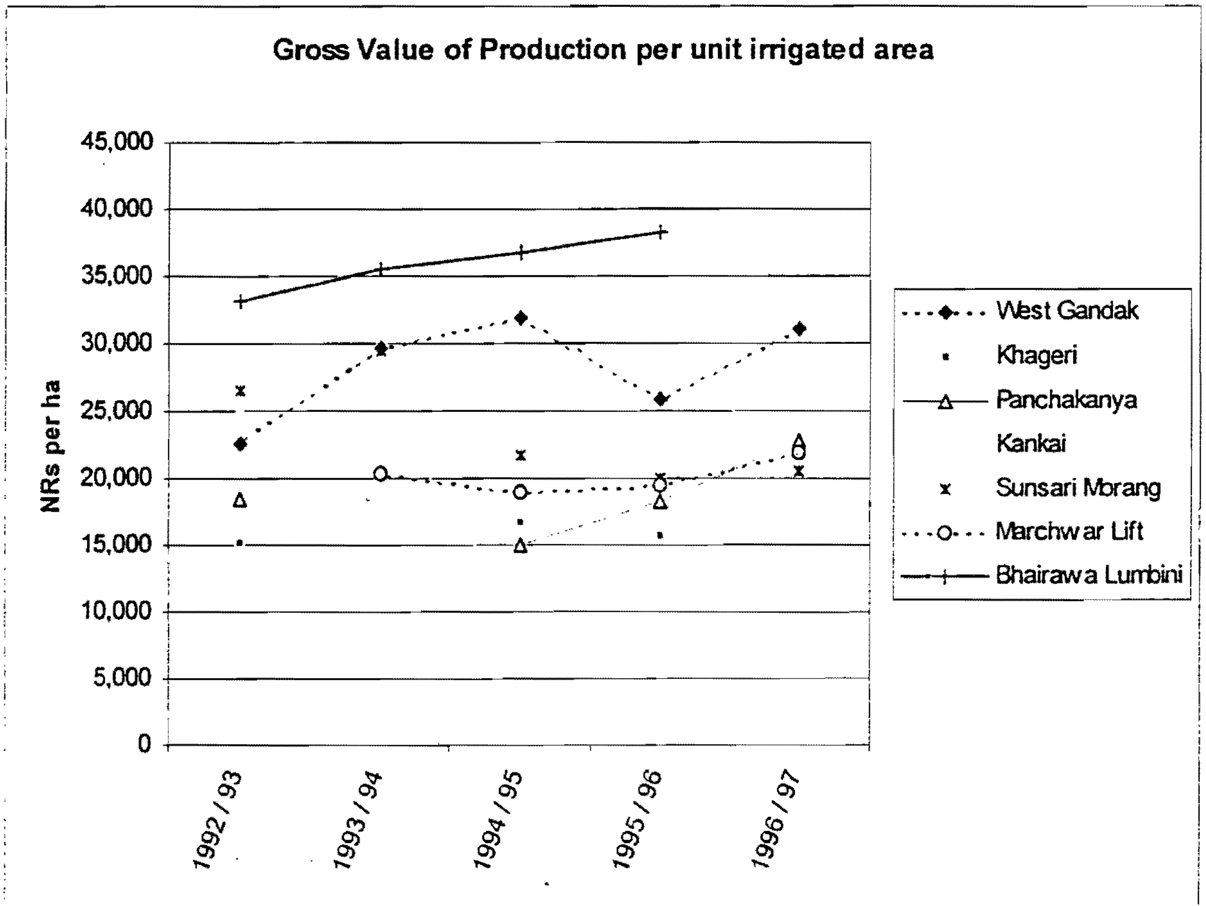
Graph 2.2 shows that in most schemes the GVP shows a rising trend. In the past year values fluctuated between NRs. 35,000 and 50,000 per hectare of the command area. In West Gandak the rising trend stabilized (and even dropped because the cropping intensity went down) after 1994/95 when the rehabilitation works completed. It would be interesting to monitor whether the increased level of output in the other schemes can be sustained after the rehabilitation and other support programs come to an end. In Sunsari Morang the GVP fluctuates but remains more or less on the same low level. The values are low due to the relatively low irrigation intensity and lack of crop diversification. On the other hand the values for Bhairawa Lumbini Groundwater Project are high due to well-developed crop diversification. The flexible water delivery of individual wells facilitates this diversification.

Gross Value of Production per unit Irrigated Area

The GVP per unit area reflects the average productivity from a hectare of irrigated land. It depends on the cropping pattern, yields and prices.

Graph 2.3 clearly indicates that among the studied schemes, in Bhairawa Lumbini Groundwater Project the values rank highest due crop diversification and the highest reported yields of the main crops paddy and wheat. Farmers can grow high value crops (pulses, oilseed and vegetables) on a relatively large scale because of the better water control and certainty of water availability inherent in groundwater pumping schemes. Sunsari Morang has low GVP values due to lack of crop diversification and relatively low yields, probably related due to less water control (long irrigation intervals and large variations in water availability).

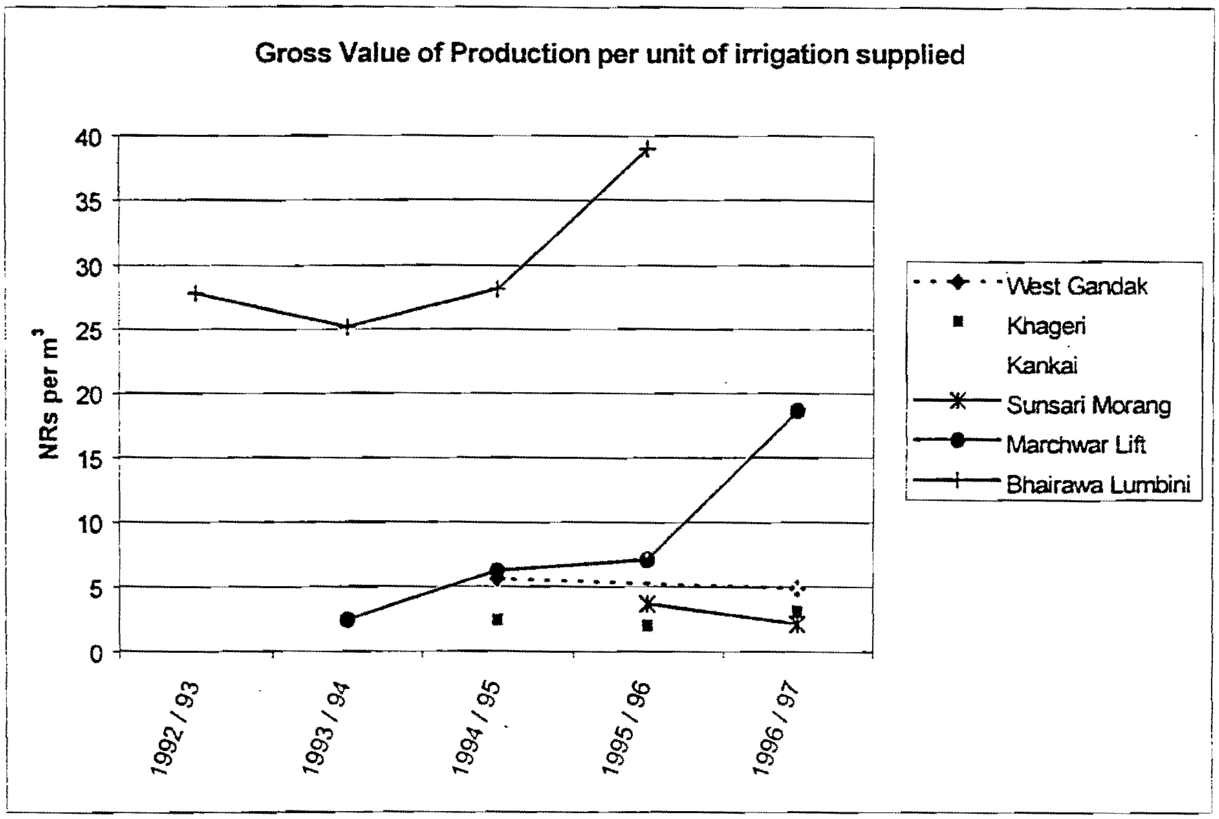
Graph 2.3: Gross Value of Production per unit irrigated area (All prices mentioned in constant 1995 rupees)



Gross Value of Production per unit of Irrigation Supplied

This indicator reflects the productivity of one unit of water supplied to the system. Unfortunately in many schemes, especially the run-of-river systems, flow records are not always reliable and often fragmented and far from complete. Generally, water flows in the river are highly variable and canal discharges fluctuate accordingly so that frequent measurements need to be taken. Despite these limitations, the general picture as shown in graph 2.4 is clear. In the run-of-the-river systems, the output is low while the output per unit in both pump systems is elevated. Every additional unit of water supplied involves additional expenditures (mainly energy costs). Hence, there is a direct incentive to reduce the amount of water supplied to a minimum. In run-of-the-river systems the costs per additional unit of water supplied is close to zero and because of the lack of storage facilities incentives for individual schemes to supply less water are low. Remarkable is the sharp rise in the Marchwar Lift Irrigation Project. From 1995/96 onwards, farmers started to contribute to energy expenses to run the pumps. For the WUA, this was a strong stimulus to improve irrigation efficiencies in order to reduce the amount of water pumped. The same is true for Bhairawa Lumbini after 1993 when the project started to turn over part of the tube wells. The production per unit of water in Marchwar Lift is lower than in Bhairawa Lumbini due to lack of crop diversification.

Graph 2.4: Gross Value of Production per unit of irrigation supplied (All figures in constant 1995 rupees)



Gross Value of Production per unit of Water Consumed by ET_{crop}

This indicator reflects the water productivity in the real sense i.e. the returns for every unit of water extracted from the hydrological cycle[8]. Exact data on the water balance and the amount of water depleted are not available. Therefore, the amount depleted is approximated by the crop evapotranspiration computed with CROPWAT[9].

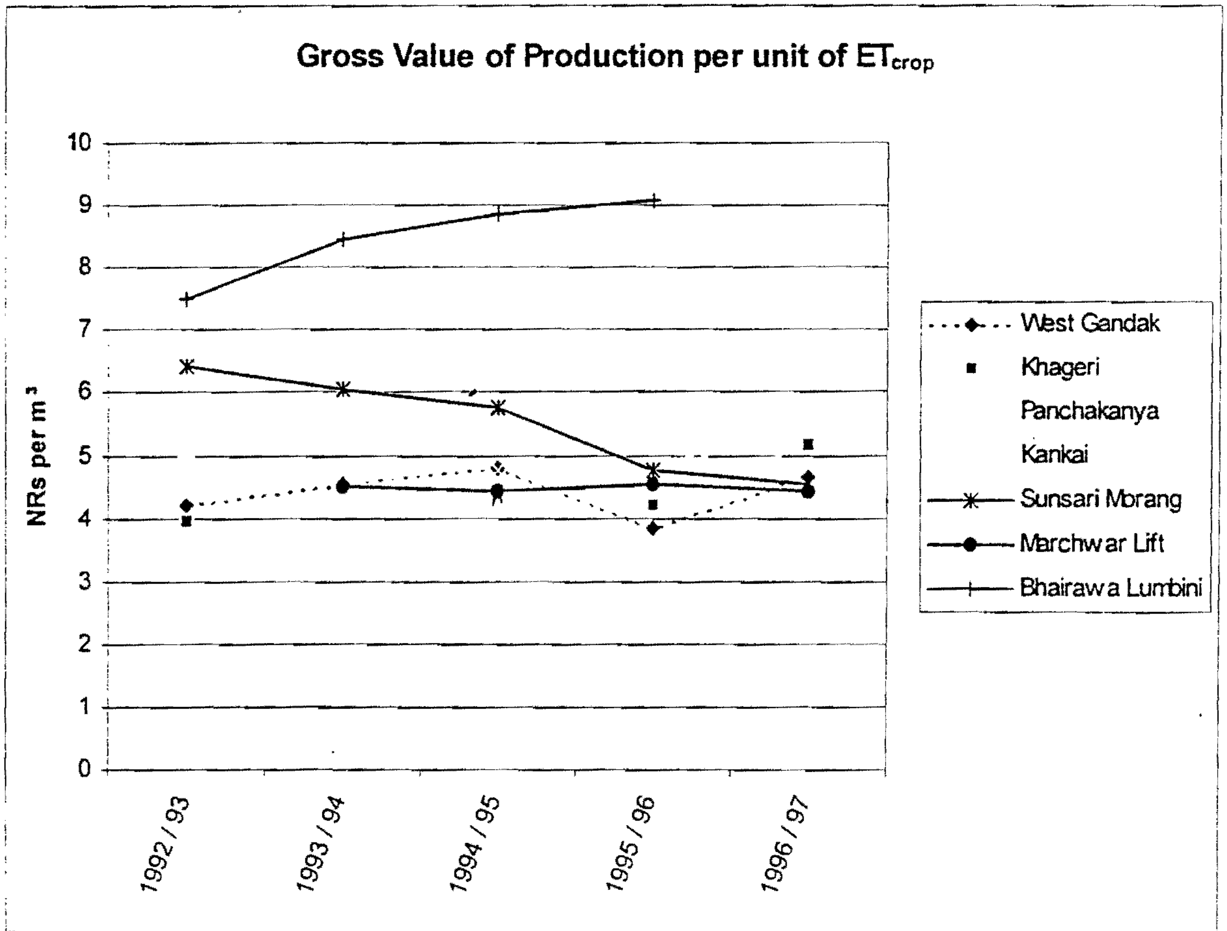
[8] Depleted means rendered unavailable for other uses for example by crop evapotranspiration, evaporation from water bodies and soil, losses to sinks or by pollution.

[9] This computer program calculates the reference ET according to modified Penman-Monteith.

Graph 2.5 shows the results for the seven schemes over the past 5 years. The values for Bhairawa Lumbini are highest due to the crop diversification. The values for Sunsari Morang show a declining trend because yields of both main crops are decreasing slightly.

For the lift and groundwater schemes the GVP per unit of water supplied is substantially higher than per unit of ET_{crop} indicating that a large part of the evapotranspiration is met by rainfall. This implies an efficient use of the rain in combination of the irrigation supply. In the run-of-the-river schemes there is no incentive to use the rain more efficiently in order to reduce water supply.

Graph 2.5: Gross Value of Production per unit of water consumed by ET_{crop} (All figures in constant 1995 rupees)



Relative Water Supply and Relative Irrigation Supply

The Relative Water Supply (RWS) indicates the amount of water available in the form of rain and irrigation supply in relation to the total crop water demand. In other words it gives an indication on how tight the system is in water supply. The Relative Irrigation Supply (RIS) is given by the amount of irrigation supply in relation to the irrigation requirements. It is a measure of adequacy of irrigation water supply. Tables 2.3 and 2.4 present the computed values. Unfortunately due to limited reliability and erratic availability of data on water supplies no firm conclusion could be drawn. However, RWS values of well over 2.0 for most schemes in most years suggest abundant water availability. Care should be taken with the interpretation of RWS. The values are taken as an average over the whole year and therefore do not show short periods of water shortage that in practice may hamper agricultural production.

The Relative Irrigation Supply is substantially lower for both pump schemes, which is explained by the fact that they apply less water because of the high expenses involved.

Table 2.3: Relative Water Supply

Year	West Gandak	Khageri	Sunsari Morang	Kankai	Marchwar Lift	Bhairawa Lumbini
1996 / 97	2.36	3.85	4.32	3.31	2.12	
1995 / 96		4.60	3.21		2.09	1.97
1994 / 95	1.60	3.44			2.42	2.19
1993 / 94					4.09	2.18
1992 / 93						2.03

Table 2.4: Relative Irrigation Supply

Year	West Gandak	Khageri	Sunsari Morang	Kankai	Marchwar Lift	Bhairawa Lumbini
1996 / 97	2.29	2.88	3.89	1.91	0.68	
1995 / 96	0.96	5.71	2.03		0.50	0.27 (?)
1994 / 95	1.22	2.34			1.10	0.72
1993 / 94					2.79	0.49
1992 / 93						0.48

Financial Self-Sufficiency and Fee Collection Rate

All studied schemes are in the process of irrigation management transfer or are recently been turned over to the users, fully or partially. One of the elements in the management transfer is that users will pay all operation and maintenance expenditures. This is a process of a number of years in which the irrigation service fee will be gradually increased to meet real expenses. The Financial Self-Sufficiency (FSS) reflects the degree to which farmers are bearing O&M expenses. For example, if the FSS is 25 %, farmers are paying 25 % of all O&M expenditures through water fees while 75 % is paid by government subsidies. Consequently, one of the targets of the management transfer program is a financial self-sufficiency of at least 100 % in the coming years.

The fee collection rate indicates the percentage of the targeted amount of water fees actually collected. If all beneficiaries are paying the full amount of their water fees this value will be 100 %. Obviously, the WUA will target for a 100% fee collection rate, to be able to meet O&M expenses[10]. Before the transfer in most schemes farmers were not paying for their water.

Looking at the numbers for the studied schemes presented in table 2.5, one can see that although progress has been made, still a lot has to be done in this area. In the BLGWP, the ISF policy seems most strict: the WUAs of the recently turned over schemes pay the full amount implying a FSS of 100 %[11]. Fee collection rates are also high because in groundwater systems it is relatively easy to exclude non-paying beneficiaries from irrigation water supply. The IMTP paid a lot of attention to fee collection and WUA's training for financial record keeping. In the IMTP sites (viz. West Gandak, Khageri and Panchakanya) these efforts are reflected in rising fee collection rates and rising values of FSS. The lowest values of FSS and fee collection rates are found in Kankai, Marchwar and Sunsari Morang. Until now most efforts in the irrigation management transfer process in those schemes focused on rehabilitation works rather than on financial management by the WUAs.

Table 2.5: Financial Self Sufficiency (%)

Year	West Gandak	Khageri	Pancha-kanya	Sunsari Morang	Kankai	Marchwar Lift	Bhairawa Lumbini
1996 / 97			48	4	3	3	-
1995 / 96	10	24	23	2	4	2	-
1994 / 95	4	28	0	0	2	2	-
1993 / 94	2	22	0	0	1	0	-
1992 / 93	0	0	0	0	4	0	49
1991 / 92	0	0	0	0	0	0	44

Table 2.6: Fee collection rate (%)

Year	West Gandak	Khageri	Pancha-kanya	Sunsari Morang	Kankai	Marchwar Lift	Bhairawa Lumbini
1996 / 97	48		65	24	51	24	-
1995 / 96	37	58	91	27	63	43	-
1994 / 95		67		2	41		-
1993 / 94		56			6		-
1992 / 93		56			70		91
1991 / 92					40		89

All studied systems are facing problems to raise water fees according to the assessed amount. In most schemes less than half of the fees due was collected. Over the years the collected amount can vary considerably without a clear reason. Currently, IWMI is

[10] Note that the Financial Self Sufficiency takes into consideration the actual expenses, which not always reflect O & M requirements.
[11] Not mentioned in table because some tube wells have been turned over and others not yet. So, it is hard to give a generalization for the whole scheme.

conducting a detailed study concerning water fees and mechanisms to collect them. This study will provide more insight in this important issue.

O&M Expenditures per Unit of Land

Besides evaluating the Financial Self-sufficiency it is essential to monitor O&M expenditures per unit of land to check whether sufficient resources are being allocated to maintain the system properly. Ideally, one would like to compare O&M requirements with the actual O&M expenses. Unfortunately, realistic assessments of O&M requirements based on maintenance surveys are hardly ever done. The requirements will differ from scheme to scheme, depending on type and location. In this study, therefore, a time series of data is taken to see whether there are clear trends or sudden changes.

Graph 2.6 shows the total O&M expenditures (including WUA contributions) per unit of the command area over the last 5 years. It raises a few concerns. The first is the enormous variation in budget allocation without a clear explanation. The expenses vary roughly from 100 to 2000 NRs per ha (all in constant 1995 rupees). Obviously, a pump of the river system such as Marchwar Lift has higher operational costs due to high-energy costs inherent in pump systems. But it is less clear why for example O&M expenditures in the IMTP sites are much and much lower than in Kankai or Sunsari Morang. From the data it is not exactly clear what guideline the Department of Irrigation is currently using for their budget allocations. Secondly, there is a clear descending trend in expenditures expressed in constant 1995 rupees. The O&M allocations (corrected by inflation) by the government are going down. The WUA's contributions still are very modest in comparison with overall expenditures and do not fill the gap of declining HMG expenses. If this trend persists the sustainability of the irrigation infrastructure might be endangered.

The O&M expenses per unit of land are low in comparison with the Gross Value of Production. In the run-of-the-river systems the O&M expense consist of less than 1% of the production. Only in Kankai this amounts to 2%. Even in both pump systems with high running costs this percentage does not exceed 5%.

Graph 2.6: O&M expenditures per unit of the command area (All figures in constant 1995 rupees)

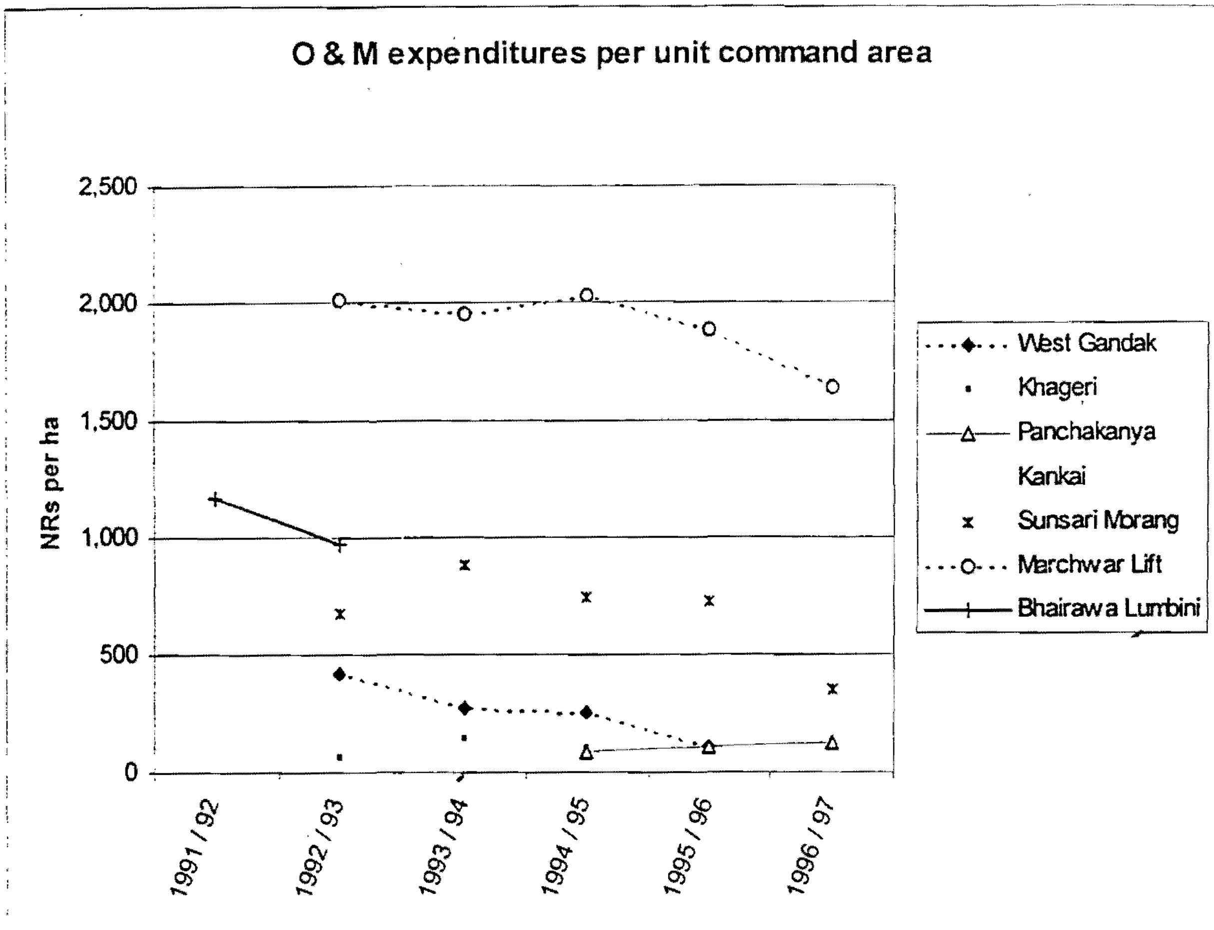


Table 2.7 provides data on the O&M expenditures per unit of irrigation supplied. Obviously, both pump systems have high expenses in comparison with the run-of-the-river schemes. Still, it makes up less than 10 % of the Gross Value of Production per unit of water supplied.

Table 2.7: Total O & M expenditures per unit of water supplied in constant 1995 rupees per 1000 m^3

Year	West Gandak	Khageri	Sunsari Morang	Kankai	Marchwar Lift	Bhairawa Lumbini
1996 / 97	9	7	67	96	509	
1995 / 96	27	7	262		769	
1994 / 95	41	7			399	
1993 / 94	44				515	
1992 / 93						570

Further research is necessary to monitor if the declining O&M expenses (including both government and WUA contributions) negatively affects a proper maintenance of the schemes and hence, endanger sustainability in the long run.

CONCLUSIONS

The performance assessment was centered on the following questions:

- What are the trends in performance of irrigated agriculture?
- What are the impacts of Management Transfer on irrigation performance?

Trends in Performance

- Agricultural production per unit of land is rising with increasing irrigation intensity and improved paddy and wheat yields.

- Agricultural production per unit of water supplied is rising in both pump schemes because agricultural production is increasing while water supply is getting less. Farmers started economizing water supply after they had to pay part of the energy expenses. For the run-of-the-river systems there was no change.

- The Financial Self-sufficiency reflecting the degree to which WUAs are contributing to O&M expenses is rising over the last few years, but still are far from the targeted 100 % value.

- The fee collection rates fluctuate considerably per scheme and over the years. Generally they are low, indicating problems in collecting water fees.

- O&M expenditures per unit of land are declining because the government is allocating smaller budgets and WUA contributions still are modest. Government budget allocations per unit land differ considerably from scheme to scheme. From the data it is not very clear which guidelines are used for budget allocations.

- In general O&M expenses are low and constitute less than 1 % of the Gross Value of Production.

Impacts of Irrigation Management Transfer

- Agricultural production went up, mainly because of the rehabilitation works proceeding the actual irrigation management transfer. It should be monitored carefully if the agricultural production is to be sustained at the increased level after the transfer and withdrawal of the project.

- Farmers started contributing to the O&M expenditures. However, the government is still paying by far the major part of the expenses. Still, a lot of progress has to be made before farmers will be able to bear the costs to run the system. Meanwhile, O&M expenses are declining and this might endanger the sustainability of the irrigation infrastructure.

Issues Needing Further Attention

- O&M allocation policy by the government
- Improvement in fee collection rates
- M&E system: quantity and quality of data
    - Gaps in time series data
    - Lack of flow measurements
    - Data scattered over different locations and offices
    - Data collected by consultants might lead to bias to show progress