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WATER, ENVIRONMENT AND MANAGEMENT

Water management at deep tubewells

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BACKGROUND

In common with many irrigation projects, the Deep Tubewell II Project (DTW II) found command areas substantially lower than had been envisaged when the project was planned. To try to improve the situation, the project used 40 of its 4 000 tubewell sites to demonstrate the practices recommended in the Bangladeshi Irrigation Management Programme (IMP). These included standard guidelines:

-engineered channels to take the full flow (56 l/s)
-allocation of water to blocks of land in rotation
-irrigation to start from the furthest point from the source.

Farmers had been reluctant to adopt the IMP recommendations, and there was growing evidence that they had sound reasons, beyond simple conservatism. For example, Mott MacDonald (1991) found evidence that the rigidity of block rotation could lead to small farmers losing income from casual labouring.

DTW II, in conjunction with Bangladesh Agricultural Research Institute launched a water management study in 1988 to assess the benefits to farmers of the IMP. It expected to be able to quantify the water savings (or increased production) which could be made, and compare them with the direct and indirect costs of implementing the recommendations. What it concluded (Mott MacDonald, June 1992) was that on the grounds of water use efficiency alone, the farmers were often right to ignore the recommendations.

CONVEYANCE SYSTEMS

Water losses from earth canals were measured at three engineered schemes and nine farmer-designed schemes. Using methodology adopted from Trout (1980) and described by Rashid et al (March and October 1991), the losses were divided into transient (dead storage and wetting losses) and steady state (mainly overtopping, cracks & holes, and seepage & percolation) components.

Transient losses were found to be negligible. Dead storage, for example, was found to account for, at worst, 3 minutes of pump time per day.

The comparison of results was complicated by two factors. Firstly, at some of the farmer-designed schemes the flow is split close to the well and two or more canals are operated simultaneously. Secondly, the discharge at the older wells was considerably lower than the nominal (56 l/s).

Records of the channel use over a season were kept, and from these the time-averaged channel length was calculated. As expected, the length at the schemes where the flow is split into two is approximately double the length at schemes where the feeder channels take the whole flow.

Using Manning's Equation, it was possible to estimate the change in wetted perimeter which would result from changing the discharge to the design level. The precise assumption made for Manning's n did not significantly alter the percentage variation in wetted perimeter.

Assuming that the steady state losses were proportional to the wetted perimeter, the measured results were scaled to an equivalent inlet flow rate of 56 l/s. The results are shown in the table. It shows that the losses from the engineered feeder channels were 30% lower than from the farmer-designed canals. Thus the percentage of pumped water reaching field level through intentional outlets is 52% at the engineered schemes , compared only 39% at the farmer-designed schemes. There was little variation between schemes on different soil associations.

WATER USE

But this is not the whole story. Up to 83% of the water loss was through holes, cracks and by overtopping (collectively termed 'visible leakage'). This water flows into plots adjacent to the canals. Of the remaining loss (seepage and percolation, S&P), some will flow into neighbouring plots. As a first estimate, we assumed that all visible leakage contributes to the field irrigation requirement. This produces a very different picture. Although the losses from farmer designed canals are much higher, the proportion of visible leakage is also higher. Thus the total (intentional and leaked) supply to field level is almost the same in the farmer-designed and the engineered schemes. In other words, the construction of an engineered scheme had not altered the volume of water available at field level, it had simply changed the method of delivery, increasing management control.

It has been argued that increasing control will increase the efficiency with which water is used at plot level. Water which leaks into a field near the tubewell will be wasted, it was said.

Feeder Channel Losses

	Soil association	Actual Loss Rate				Adjusted Loss Rate[3]
		Holes & cracks	Over-topping	Seepage & Percolation	TOTAL	
		%	%	%	l/s	l/s
Engineered schemes[1]	Young Brahmaputra	51	19	30	17.2	16.9
Farmer-designed schemes[2]		61	15	23	23.1	24.5
	Old Brahmaputra	38	37	25	17.6	22.3
	Madhupur Tract	53	29	17	20.1	24.4

Notes: [1] 1990-91 season [2] 1991-92 season except Young Brahmaputra 1990-92 seasons. [3] to nominal flow rate of 56 l/s.
Source: DTW II Water Management Study

During paddy irrigation (the major crop grown was rice) water flows in and out of individual plots by direct irrigation, leakage from canals, plot-to-plot transfer, crop use, evaporation, run-off to drainage channels, and percolation. To measure all these was beyond the scope of this study, but we needed to make an estimate of in-field use.

We started from an assumption: despite inequities in water allocation, all plots receive enough water to satisfy the field irrigation requirement. Farmers behave rationally; if they do not believe it is profitable to use tubewell water for irrigation (for example, if supply is inadequate), they will stop buying water. Thus, where command areas are stable or increasing, it is likely that most plots receive sufficient water.

The actual command area (CA), then, is a measure of the water used. It was compared to two potential command areas. We defined the 'potential command area at 100% efficiency', PCA_{100}, as the area which could be irrigated if all the pumped water was used to satisfy the field irrigation requirement. It was based on the peak water demand (crop water use plus percolation) during the growing season assuming a rice monoculture. The 'potential command area at scheme conveyance efficiency', PCA_{conv}, was defined as the area which could be irrigated at the given conveyance efficiency, assuming that all leaked water was lost to the system.

A comparison of actual command area to PCA_{conv} shows that CA/PCA_{conv} is considerable higher than 1. It shows that water which leaks from the canals must be used to contribute towards the field water requirement.

The ratio of CA to PCA_{100} is an approximation to the overall efficiency of the system, ie, the ratio of the water used in the field to the water which could be pumped. At the farmer-designed schemes, CA/PCA_{100} was found to be 90%, higher than at the engineered schemes (75%). In other words, the farmer-designed schemes were irrigating a greater proportion of their potential than the engineered schemes.

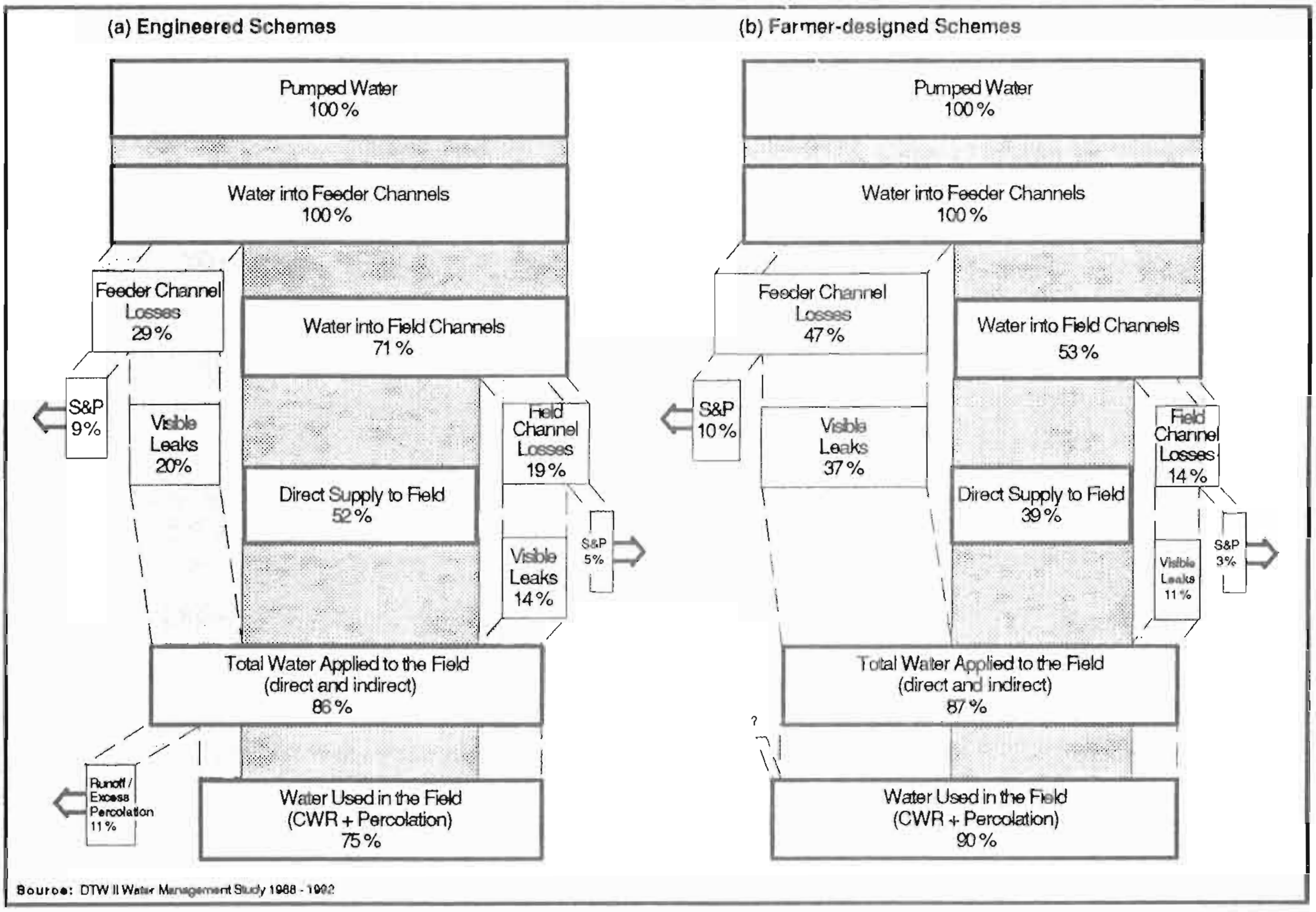
A summary of the water flow patterns can be seen in the figure. At the engineered schemes, the canal system is indeed more efficient than the farmer-designed canals, but this does not adversely affect the volume of water which is available at field level, since a large proportion of the leaks from the canals flow directly into the field. Assuming that all visible leaks contribute to the field irrigation requirement and that S&P from the canals is lost appears to be a reasonable assumption. The comparison of the CA/PCA_{100} at the two types of scheme disproves the theory that increased control leads to increased command area; at the farmer-designed schemes 90% of the potential command area is irrigated, compared to 75% at the engineered schemes.

THE ROLE OF IRRIGATION ENGINEERING

It might appear from the above that irrigation engineers have little of use to say about tertiary irrigation management. The IMP guidelines are based on standard irrigation messages, and they have not resulted in benefits for farmers at our study schemes. However, the results point to some areas where these recommendations are still relevant.

Where rice is not the only crop, water leaking from canals has much more serious consequences, since wheat and many vegetables are damaged by excess water. Thus an improved conveyance system may be necessary to enable successful crop diversification.

Where specific obstacles to command area expansion exist, localised engineered systems may be necessary to overcome it. For example, a buried pipe to cross a drainage channel, or a lined canal to pass an area of sandy soil.



Source: DTW II Water Management Study 1988 - 1992

Water Flow from Tubewell to Field

CONCLUSIONS

Farmers should be encouraged to adopt whatever management systems suit their local needs. Models which have proved successful during pilot programmes will not automatically transfer well to general use.

The economic advantages of a new system should be assessed from the point of view of the people making the investment. The returns need to be realistically quantified; increasing water supply to the field level will not necessarily increase the command area. Even if it does, this may not benefit the management who made the investment in an improved conveyance system.

The study also identified various areas which might benefit from further study. Briefly, these are thought to be:

- percolation rates; data for these in Bangladesh were very approximate
- command area expansion; effect on CA/PCA$_{100}$ when the PCA increases, say due to the discharge being increased
- water charge systems; the effect of the payment method on the scheme performance.

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