Madras Agric. J., 81(5): 263-267 May, 1994

https://doi.org/10.29321/MAJ.10.A01515

A SIMULATION ANALYSIS OF WATER USE IN KRP

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ABSTRACT

A simulation model was developed for Krishnagiri Reservoir Project (KRP), a surface irrigation system in Tamil Nadu. This model was used to evaluate the performance of the irrigation system under existing and optimum water use situations with change in crop pattern, lining of main canal and distributories. The model operated on a daily basis using data relating to rainfall, inflow, outflow, evaporation loss, seepage and percolation loss. The results of the study indicated that at existing water use level, there is considerable water deficit even with ground water supplementation and the physical improvements with change in crop pattern will not only reduce the water deficit but also increases the scope for area expansion.

In Tamil Nadu there are 62 reservoirs with an ayacut area of 810 thousand ha in 1988-89 and it constitutes 34.12 per cent of the total net area irrigated in the State. Some of the constraints that limit the performance and productivity of these irrigation sytems are problems of water logging, soil salinity, neglected maintenance, inefficient operation, excessive use of water, wastage of water, lack of conjunctive use of surface and ground water, inefficient distribution system, lack of infrastructure facilities, etc.

Krishnagiri Reservoir Project (KRP) is an irrigation project in Dharmapuri district of Tamil Nadu with command area of 3648.58 ha. The farmers in KRP ayacut area are experiencing excessive water use in upper reaches and severe water stress in tail end areas. Thus inequitable distribution of water and water use pattern resulted in imbalances and instability in production and income distribution. So the farmers are facing non availability of adequate water on one hand and improper distribution and poor water management on the other hand. There is also wide spread salinity/alkalinity in the ayacut area.

The present study specifically aims at to develop a simulation model and examine the effects of conjunctive use of surface and ground water and to sensitise the model with the selected policy options.

The Simulation Model : Simulation is an appropriate technique to study the performance of an irrigation system becasue it facilitates in identifying and analysing a given problem, finding a set of alternative solutions and selecting and implementing the most feasible solutions. In India the performance of the different irrigation systems such as large surface irrigation, tank irrigation and conjunctive use of tank and well irrigation were studied using simulation approach by the earlier researchers. (Palanisami and Flinn, 1988, Galang and Bhuiyan, 1989, Manteuffel, 1982, Ahmed and Heermann, 1988 and Ramu, 1986).

In this study, simulation of various policy options such as lining of main canal, lining of main canal and distributories, changes in crop pattern etc., were resorted to and their impact assessed.

The flow chart of the KRP irrigation system simulation model is shown in Fig.1. The input to the model includes the data on daily rainfall, daily inflow into the dam, daily outflow into the main canals, daily evaporation loss, daily percolation and seepage loss, full dam capacity, existing conveyance loss and special release to Barur tank, a large irrigation tank forming part of the KRP system. The model computes daily water balance in the dam by adding inflow through the river and rain water in the water spread area of the dam. The total storage at the beginning of each day is calculated by adding previous days storage to the inflow and rain water on that particular day. The storage at the end of each day is calculated by subtracting evaporation loss, percolation and seepage loss, special release to Barur tank and outflow into the two main canals, from the storage at the beginning on that day. The reservoir can not hold more water beyond its maximum capacity. So provisions are made in the model to restrict the storage quantity to the maximum capacity of the dam, if the storage exceeds the capacity.

WATBAL on i^{th} day = WATBAL on i -1 th day + INFLOW + RAINWTR - OUTFLOW RMC - OUTFLOW LMC - EVAP LOSS - PERSELOSS- SPLRLSC.

Where

WATBAL on i^{th} day = Water balance on i^{th} day
WATBAL on i-1th day = Water balance on previous day to the i th day
INFLOW = Inflow into the dam through river on each day
RAIN WTR = Rain water received over the water spread area of the dam on the particular day
OUTFLOW RMC = Outflow into the right main canal on each day
OUTFLOW LMC = Outflow into the left main canal on each day
EVAPLOSS = Evaporation loss on each day
PERSELOSS = Percolation and seepage loss on each day
SPLRLSC = Special release to the Barur tank

For calculation of water balance equation the irrigation season starting from 1st June to 31st May was considered. The average run off at KRP was estimated at fifty per cent and the existing conveyance loss was estimated at forty per cent.

Existing and optimum crop water requirement : At the time of field survey it was observed that crops were over irrigated which indicate the scope to improve the efficiency of water use at the field level. Hence the existing water requirment for 2800 ha of paddy and 850 ha of other crops such as sugarcane, coconut, mango, ragi, turmeric and groundnut was calculated at the existing rate and at optimum level of use in the head, middle and tail regions.

Change in crop pattern : A closer technical assessment revealed that an additional area of 450 ha of rice could be replaced by non-wet crops, the cultivation of which will not only, enhance the economic returns and help the farm operators but also save the water to increase the cropping intensity. The technical assessment of crop substitution was made possible by closely interacting with the agronomists in the nearby experimental stations, officials of irrigation and agriculture departments and leading farmers in system command.

Lining of main canal and distributories : Modernisation of irrigation system normally includes lining of main canals and distributories which could be effective in saving the water. The lining of main canals could save 15 per cent during conveyance loss and the lining of distributories will increase the water supply further by ten per cent. This assumption was based on Sally (1965).

Ground water supplementation : The ground water supplementation particularly in the tail

Table 1. Simulations of KRP system with lining of main canal and distributories (mcuft).

Particulars	Lining of main canal		Lining of main canal and distributories	
	Existing water use level	Optimum water requirement level	Existing water use level	Optimum water requirement level
Water balance on 1st November	2351.535	2351.535	2351.535	2351.535
Total inflow through river (Nov-April)	436.752	436.752	436.752	436.752
Water quantity added to the reservior (Nov-April)	14.702	14.702	14.702	14.702
Total water availability	2802.989	2802.989	2802.989	2802.989
Evaporation loss	240.161	240.161	240.161	240.161
Percolation and seepage loss	720.483	720.483	720.483	720.483
Special release to Barur tank	160.013	160.013	160.013	160.013
Outflow into LMC and RMC	1496.967	1496.967	1496.967	1496.967
Conveyance loss at 25 per cent	374.242	374.242	-	
Conveyance loss at 15 per cent			224.545	224.545
Water availability at field level	1122.725	1122.725	1272.422	1272.422
Water requirement at field level	1644.933	1386.933	1644.933	1386.933
Deficit	522.208	264.228	372.511	114.531
Balance of water on April 30th	185.365	185.365	185.365	185.365

LMC : Left Main Canal RMC : Right Main Canal

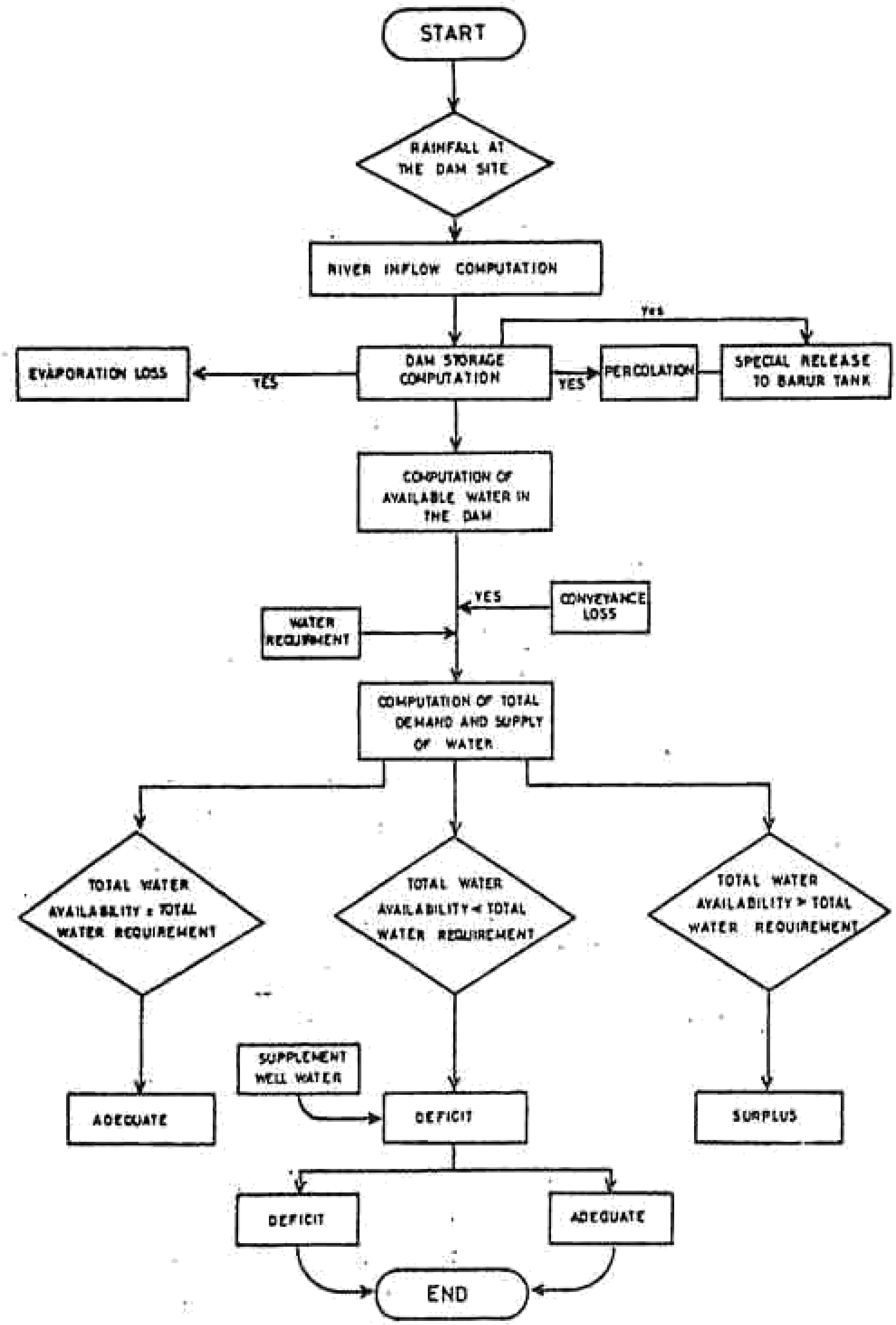

Fig. 1. Flow Chart of the KRP Irrigation system simulation model

region is a very common practice. An estimated 1480 wells are there in the KRP ayacut area and their supplementation potential was estimated at 592 mcuft (million cubic feet).

Results of the Simulations : The water balance as on November 1st was 2351.535 mcuft and by adding the inflow, rainfall at dam site, the total water availability was estimated at 2802.989 mcuft. After deducting the evaporation loss, seepage and percolation loss and special release to Barur tank, from the total water availability, the total water released for irrigation in the command area was 1496.967 mcuft. When we deduct the conveyance loss, the actual field level availability of water worked out to be 898.180 mcuft as against

Table 2. Simulations of KRP system with change in crop pattern, along with lining of main canal and distributories (mcuft).

Particulars	Change in crop pattern under normal conveyance efficiency		Change in crop pattern with lining of main canals		Change in crop pattern with lining of main canal and distributories	
	Existing water use level	Optimum water requirement level	Existing water use level	Optimum water requirement level	Existing water use level	Optimum water requirement level
Water balance on 1st November	2351.535	2351.535	2351.535	2351.535	2351.535	2351.535
Total inflow through river (Nov-April)	436.752	436.752	436.752	436.752	436.752	436.752
Water quantity added to the reservior (Nov-April)	14.702	14.702	14.702	14.702	14.702	14.702
Total water availability	2802.989	2802.989	2802.989	2802.989	2802.989	2802.989
Evaporation loss	240.161	240.161	240.161	240.161	240.161	240.161
Percolation and seepage loss	720.483	720.483	720.483	720.483	720.483	720.483
Special release to Barur tank	160.013	160.013	160.013	160.013	160.013	160.013
Outflow into LMC and RMC	1496.967	1496.967	1496.967	1496.967	1496.967	1496.967
Conveyance loss at 40 per cent	598.787	598.787	-	-	-	-
Conveyance loss at 25 per cent	-	-	374.242	374.242	-	-
Conveyance loss at 15 per cent	-	-	-	-	224.545	224.545
Water availability at field level	898.180	898.180	1122.725	1122.725	1272.422	1272.422
Water requirement at field level	1501.927	1267.180	1501.927	1267.782	1501.927	1267.782
Deficit	603.747	369.602	379.202	145.057	229.505	4.64*
Balance of water on April 30th	185.365	185.365	185.365	185.365	185.365	185.365

LMC : Left Main Canal RMC : Right Main Canal * Surplus water

the water requirement of 1644.933 mcuft at existing water use level and 1386.953 mcuft at optimum water use level. The water deficit was 746.753 mcuft at existing water use level and it drops to 488.773 at optimum water requirement level. The ground water supplementation potential was 592 mcuft in the KRP command area and even after considering this, still there exists a deficit of 154.753 mcuft at existing water use level. But one has to bear in mind, the potential well water in head region is underutilized, at the same time the well water is exploited to the maximum in tail region. There will be a surplus of 103.227 mcuft, if the farmers could use the surface and ground water conjunctively at optimum water requirement level. The balance of water 185.365 mcuft needs to be maintained as the dead storage level.

The simulation results of KRP system with lining of main canal and distributories for existing and optimum water use levels were presented in Table 1. It could be seen from the table that the total water availability was 2802.989 mcuft, and after subtracting the various losses like seepage and percolation loss, evaporation loss and conveyance loss and special release to Barur tank, the actual water availability at field level was 1122.725 mcuft in the case of lining of main canal alone, an increase of 15 per cent in water availability. The availability increases to 1272.422 mcuft in the case of lining of main canal and distributories. This means the total availability increased by 25 per cent over the level available in the absence of lining.

In other words, the lining of main canal alone reduced water deficit by 224.545 mcuft at existing water use level and 482.525 mcuft at optimum water requirement level. This is because the lining prevented 15 per cent of the conveyance loss. When ground water supplementation is effected, there may not be any water shortage in the ayacut even at the existing water use level. With ground water supplementation, it is possible to bring additional paddy area to the extent of 159 and 744 ha at existing water use level and optimum water requirment level, respectively.

When the lining is extended to distributories also, the water deficit is estimated at 372.511 mcuft at existing water use level and 114.531 mcuft at optimum water requirement level. That is, the surface water shortage could be reduced significantly. Evidently, both lining of main canal and distributories and supplementation of ground water, eliminates water deficit, totally, even at existing water use level. The scope for additonal area expansion under paddy was 499 ha at existing water use level and 1081 ha at optimum water requirement level.

The simulations of changes in crop pattern, alongwith lining of main canal and distributories were presented in Table 2. It could be seen from the table, under normal conveyance efficiency, the change in crop pattern to the extent of 450 ha may result in with acutal water availability at field level of 898.180 mcuft. This will result in a water shortage of 603.747 mcuft at existing water use level as against 369.602 mcuft at optimum water requirement level. This indicates that the ground water supplementation is a must even at the changed crop pattern level to manage the water deficit.

The change in crop pattern coupled with lining of main canal may result in with actual water availability of 1122.725 mcuft. The table further showed that the surface water deficit was 379.202 mcuft at existing water use level and 145.057 mcuft at optimum water requirement level. With effective ground water supplementation, the scope for additional area expansion under paddy was 483 and 1014 ha at existing water use level and optimum water requirement level, respectively. So the strategy of change in crop pattern with lining of main canal alone may not be sufficient to overcome the surface water deficit in the KRP ayacut area.

The simulations with change in crop pattern along with lining of main canal and distributories revealed that the actual water availability at field level with 1272.422 mcuft and the surface water deficit was 229.505 mcuft at existing water use level and a surplus of 4.64 mcuft under optimum water requirement level. It is interesting to note that there was a surplus of 4.64 mcuft under optimum water requirement level, even without ground water supplementation. So the strategy of change in crop pattern with lining of main canal and distributories is an ideal one to overcome the surface water deficit in the KRP ayacut, provided the farmers used the surface water at optimum water require ment level.

Conclusion : The results of the simulation exercises indicated that strategies like optimum water use by farmers, lining of main canal, lining of distributories and change in crop pattern improve the over all performances of the KRP irrigation system. At present the farmers in the command area are using excessive surface water for cropping and at the same time the groundwater potential was under utilised. Educating the farmers to use water at the optimum requirement level and conjunctive use of ground and surface water may reduce the water deficit in the KPR command area significantly. The strategies like change in crop pattern and lining of main canal along with lining of distributories in fact reduces the huge surface water deficit besides providing scope for additional area expansion in the command area.

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