CHAPTER VI

SUMMARY, CONCLUSION AND IMPLICATIONS

In this chapter, a summary of the work done for the present research is presented. The salient findings are followed by the statement of conclusions drawn from the analysis and it is used to test the hypotheses of the study. Finally, the implications of the findings of the study for policy and future research are stated.

FOCUS

Tambaraparani River System originates, irrigates and ends within (old) Tirunelveli District, which has now been bifurcated into Nellai-Kattabomman and V.O.Chidambaranar districts. With three dams, eight anicuts and eleven channels and a large number of system tanks receiving supply from the channels in series, allow very intensive use of available water. Yet the pressure of growing population reflected in rapidly growing demand for farm products, especially food grains and the spread of high yielding and high fertilizer responsive crop varieties--paddy dominating among them--have built tremendous pressure on the river system for the supply of water, which has no scope for further increase and has uncertainty due to variations in inflow of water into the system from year to year. This has encouraged agricultural scientists and engineers to search for ways to improve water use efficiency further. This study is one such attempt to assess the scope for improving system's water use efficiency. Specific objectives are (a) to evaluate present system of water management
during the eighties. The last of these measures ($E_a$) was a very rough measure for the selected ayacut as a whole, and required a detailed analysis at farm level.

This farm level analysis was done in two stages. First, with the assumption that the present crop pattern in the sample farms would remain invariant, a whole farm production function was specified and estimated. It was quadratic in water use and linear in other inputs. Estimated functions were used to derive marginal value products of water and to estimate optimal water use. In the second stage, water use efficiency of crops was assumed to be invariant at levels suggested by the crop scientists and the possible changes in crop pattern were studied with the help of a Linear Programming Model for maximizing aggregate net income of the area, subject to a special restriction that paddy production would not fall below the present level for a normal year. The results of the programmes also showed the effect of the changes in the crop pattern on employment of labour. These models were formulated and solved separately for the ayacut of Melakkal and Keelakkal.

The results of all these analysis were studied with reference to the specific objective of the study to test the hypotheses and to draw inferences useful for improving water use efficiency. Salient findings are briefly stated below.

The entire command has been developed fully. There is a vast net work of official agencies to control and regulate
in the river basin; (b) to assess the productivity and equity in use of water; (c) to prepare optimal plan for maximizing water use efficiency; (d) and to suggest policies for further management of the system. However, objectives (b) and (c) were restricted to a selected anicut to keep the research within manageable limits of an individual researcher.

METHODODOLOGY

The objectives of the study required the use of both secondary data for the system and its sub-units (anicuts) for several years and primary data to evaluate efficiency in water use on-farm and to develop optimal plans for the selected subsystem of Marudur anicut. Secondary data were collected month-wise for 20 years from 1971-72 to 1990-91 from the offices of the Assistant Executive Engineers concerned. Primary Data were collected from 200 sample farms selected by a stratified and proportionate random sampling method. Stratification was done to distinguish direct and indirect (served through system tanks) ayacuts and between head, middle and tail regions of the two channels viz. Melakkal and Keelakkal of the Marudur anicut. Primary data were collected by personal interview method.

In analysing the secondary data, the first step was to define systems efficiency ($E_s$), as a combined effect of conveyance efficiency ($E_c$), distribution efficiency ($E_d$), and field application efficiency ($E_n$). Each of these four concepts was defined and their measures were formulated. These measures were compared for the normal, best and worst years of water supply in the system.
conveyance and regulation of water in the river system. There are irrigation societies managed by the farmers. It is a special feature of the system to coordinate the efforts of the officials (controlling supply) and the farmers (users of water for irrigation). The system allows for mutual discussion and decisions to avoid disputes and tensions, particularly in the years of scarcity of water. The practice of raising Advanced Kar is an innovative method adopted by farmers to utilize late season supplies effectively. A series of system tanks serve as storage cum distribution devices, to help Advanced Kar and summer paddy. Thus, the system works with a fairly high level of efficiency in water use.

Comparative study of estimates of conveyance efficiency ($E_c$), Distribution efficiency ($E_d$) and on-farm application efficiency ($E_a$) for the best, normal and worst year of water, supply consistently showed, that the water use efficiency and the supply of water had an inverse relationship, because there was a positive (direct) relationship between the supply of water and the quantity used per hectare.

 Analysis of system efficiency, component-wise showed that the field application efficiency was lowest in all the three situations (high, normal and low) even though conveyance and distribution efficiency also left much scope for improvement. This would imply that improvement in on-farm water management
would make significant contribution to the overall system-wide efficiency.

Water use efficiency at farm level was studied with the help of marginal value product of water served from whole farm production function. Equation of MVP was solved for the value of Economically Optimal Level (EOR) of water use and Technically optimal level of water use (TOR), separately for the head, middle and tail regions of the canals. It was seen that EOR and TOR showed that EOR was less than TOR in all cases as expected a priori.

* A comparative study of estimated values of EOR among the head, middle and tail regions, showed that it was the largest for head region, and the lowest for tail region, the difference arising from the crop-mix observed in the farms. Between the two canals, EOR’s were smaller for all regions of Keelakkal than those for Melakkal. Increasing cost of irrigation in middle and tail regions would explain this difference in EOR.

A comparative study of EOR with actual quantity used per hectare showed excessive use of water in all the regions. Between the channels, farms in Keelakkal used less water per hectare than the farms in Melakkal. This was consistently the case in all the three regions. EORs also were less for Keelakkal, than those for head, middle and tail regions of Melakkal. Thus, tail-enders were more efficient than their counterparts in other regions. Thus, there was no equity in the use of water.
Inequitable distribution also resulted in differences in productivity among the regions. Together they showed very low water use efficiency in the farms of Marudur anicut in general and head and middle regions in particular.

This excessive use of water could be checked, if the policy of water pricing succeeds in varying the cost of irrigation with the column of water used.

Optimization of water use was done with the help of Linear Programming exercises for three levels of water supply, with the objective of maximizing farm income rather than minimizing water use, because the farmers' goal per se was observed to be profit. Water being the most essential and critical input for the growth of crops and improvement in it through the use of high yielding crop varieties and fertilizers, its use could not fall below certain level. Therefore, the economically optimum requirement (EOR) as decided by marginal productivity of water, price of products, which it helped to produce and the price (cost) of water, could not be much different from the technically optimum requirement (TOR). Results of programming exercises were clearly consistent with this expectation.

Water requirement for the optimal crop-mix decided by the linear programmes varied from 12,710 m$^3$/ha for minimum water supply situation to 14,720 m$^3$/ha in maximum supply situation of Melakkal. The corresponding figures for Keelakkal were 12,990 m$^3$/ha and 13,660 m$^3$/ha respectively, against the requirement of
Even with these limited changes there were significant gains in terms of net income and employment in agriculture.

The results further show that in the year of good supply optimal use of water would leave a large surplus which should be conserved for the lean supply year, because good year and bad year of water supply almost alternate each other (see Table 5.1). This would require addition of reserve capacities to anicut and tanks and improvement in carrying capacity of channels.

CONCLUSION

Salient findings of the study presented above show clearly that there is vast scope for improving efficiency of water use in Tambaraparani River System. This would require improvement in conveyance, distribution and on farm application of water; the last being the most important among them. The scope for improving on-farm application of water is in both: (1) better water management practices for the crops, and (2) change in crop-mix itself. The latter was seen to improve the returns to water use in terms of net income and employment of farms and the gains were not small. The activities for the choice were few and the system is dominated by paddy crop, and that limited the scope for optimization exercise. But even within this limited options the gains were large, revealing the usefulness of such exercise. Most significant gains would, however, come from better water management practices on-farm, even for the traditional crop
pattern. Farmers need to be educated for this. All the hypotheses of this study are shown to hold.

The findings of this study, conclusions drawn and the hypotheses tested and found to be true, have some specific implications for policy and future research. They are briefly stated below.

**IMPLICATIONS FOR POLICY**

Results of this study clearly showed that productivity of water used for irrigation and equity in distribution of water in the Tambaraparani River System could be significantly improved. Early opening of the reservoir and cultivation of very short duration variety of paddy in the Kar season would enable the harvest of the first crop before the on-set of the North East monsoon. It would also help timely planting and harvesting of Pishanam crops. If Pishanam was harvested before the end of February, pulse crops could be raised with the help of rice fallow soil moisture. Gingelly would be a beneficial addition for its commercial value and suitability for rice fallow lands. But this programme would require more closer monitoring of supplies, forecast of monsoon and integrated operation of reservoirs and direct feeder to tanks (instead of the present method of feeding tank to tank).

Integrated operation of the system required provision of adequate drainage facilities for ayacuts in lower regions of the river course. Independent supply channels were required to avoid wastage of water in the upper tanks and to make timely supply of
water to the tanks lower down. It is also necessary to desilt the channels and tanks to improve their holding capacity which helps conservation of water. With better water management in Tambaraparani Command, it would be possible to reduce or even to totally avoid the drawal from Manimuthar, which, in turn, would increase cropped area in Perungal and Manimuthar New Command. All these efforts would require an Integrated Water Management Policy. Such a policy could be evolved by Engineers concerned by drawing up an optimal crop pattern and supply schedule with the help of system wide simulation exercise. The possibility of increasing storage facilities in the system net work should be explored, because it would reduce the spill-overs and excessive uses of water in head reaches. Social benefit/cost ratios must be worked out and viable options must be implemented by the government. It would improve conveyance and distribution efficiencies which are low at present.

Measures of efficiency showed that the wastage of water in the years of good supply was substantial and could be avoided by conserving excess supplies through addition of reserve storage capacities to all the anicuts. The above stated simulation study should help stabilizing inter year variations in supplies.

Equally important is the inter-month variations in supply of water in the channels. February, April and September are the months of scarcity. A change in the crop pattern would easily solve the problem.
IMPLICATIONS FOR RESEARCH

General implication of the study is that there is need to optimize water use to maximize its efficiency. Allocation efficiency, distribution efficiency and on-farm application efficiency have scope for improvement. The allocation efficiency and distribution efficiency are within the powers of the officials. It requires, however, desilting of canals and construction of canals to directly feed the system tanks. The on-farm application efficiency rests with farmers and they need to be educated, guided and corrected. Fortunately, there is a strong organisational base; it needs to be activated. All these efforts would be successful if there is a perspective plan for the TRS. For preparing such a plan the results of the study have specific implications. They are listed below.

1. This study has successfully demonstrated the usefulness of production function to determine optimal level of water use for a give crop or crop-mix. A second degree polynomial function was found to represent satisfactorily the aggregate farm production and water use relationship. It would be beneficial to repeat this exercise and to estimate crop specific production functions to determine optimal water use for specific crops. As done in this study with some training and support, farmers would be able to record and supply required data. A similar conclusion was drawn by Gulathi and Murthy.¹

2. This study demonstrated the use of optimization exercise to determine optimal crop mix subject to several
constraints, including a policy suggested constraint. It was also shown that repetition of the exercise to each of the subsystem (ayacuts of an anicut or a distribution channel) in the river system would indicate the scope for improving system wide Efficiency ($E_s$).

3. An improvement over this model is possible, to allow for inter-system transfers and to make a dynamic model to allow for inter-year transfers also. Therefore, application of systems' analysis for making operational decisions on distribution of water and crops to be raised, would have far reaching possibilities for further development of the system.

4. More complex objective functions, and additional constraints would provide even more assistance to management. This must be the thrust of future research. The application of Dantazig Wolfe decomposition principle to large scale water management, as shown by Trava et al. and Gomathinayagam and Lakshmikandan.

NOTES

