CONTROLLED WATER SAVING METHOD FOR PADDY CULTIVATION – A CASE STUDY

MÉTHODE DU CONTRÔLE D'EAU POUR SA CONSERVATION DANS LA RIZICULTURE – CAS D'ÉTUDE

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ABSTRACT

Water is one of the essential requirements for plant and animal life, but then, our water resources are limited and insufficient to meet the needs for fast growing agrictulture, industry and other uses. Also ever growing population demands more food and other basic needs which we are facing shortages at present and likely to be extended even beyond 2000 A.D. The main aspect of water resources system is the economic usage of water. About 50 percent of the total water available for irrigation in our country is diverted to rice crop alone with the assumption that the water requirement of rice is very high, without any basis for this assumption. Out of this 50 percent water is consumed by rice, 60-70 percent quantity is lost by deep percolation and evaporation. Therefore, there is an urgent need for modifying the prevalent practice of keeping standing water in rice fields and adopting means to reduce these heavy losses from the fields due to flooding, so that the excess amount of water can be saved and it can be used for increasing the irrigation potential.

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Several water saving techniques adopted in the past for paddy crop to reduce the crop water consumption were analyzed in this work.

RÉSUMÉ

L'eau représente un des besoins essentiels de la vie animale et végétale, mais le vrai est que les ressources en eau sont limitées et elles sont insuffisantes pour répondre aux exigences rapidement croissantes de l'agriculture et de l'industrie ainsi que d'autres usages. D'ailleurs, la population toujours croissante elle-même demande plus d'alimentation et d'eau pour répondre à d'autres nécessités fondamentales de l'homme malgré le manque actuel et la pénurie qui se présenteront même au delà de l'an 2000. L'aspect principal du système des ressources en eau est celui de l'utilisation économe d'eau. Suivant la supposition que le besoin en eau du riz est très élevée, environ 50% de l'eau totale disponible à but d'irrigation dans notre pays est utilisé pour la riziculture seule. Mais cette supposition n'a aucun fondement. Le riz ne consomme que seulement 50% de l'eau d'irrigation; de 60% à 70 % de cette eau est perdue à cause de la percolation profonde et de l'évaporation. Donc, il existe un besoin urgent de modifier la pratique courante de laisser stagner l'eau dans les champs de riz et d'adopter à sa place des moyens pour réduire ces grandes pertes en eau des champs inondés pour pouvoir conserver l'eau excédentaire et accroître ainsi le potentiel d'irrigation. Cette étude entreprend l'analyse de certaines techniques de conservation d'eau adoptées dans le passé pour réduire la consommation en eau des cultures.

OBJECTIVES OF THE STUDY

The objectives of the study include (i) to study the existing water distribution with special reference to paddy crop (ii) to find a strategy for controlled water saving method and to (iii) develop a knowledge base for the controlled water saving method.

STUDY AREA

The present study has been carried out in Krishnagiri Reservoir Project (KRP) ayacut area in Dharmapuri District, Tamil Nadu. The Krishnagiri Reservoir project is located in the valley of river Ponnaiyar about 3 km west of the Madras Calicut trunk road in the village limits of Periamuthur in Krishnagiri taluk of Dharmapuri district in the state of Tamilnadu as depicted in Figure 1. The catchment area of this project excluding Karnataka state catchment is 850 sq. km.

The KRP system consists of two main canals, one on the left side and the other on the right side of the reservoir running parallel to the Ponnaiyar river. The Right main canal (RMC) is having a registered ayacut of 1736 ha (4287.47 acres) and its length is 14.072 km carrying a discharge of 2.83 cum (100 cusecs). The

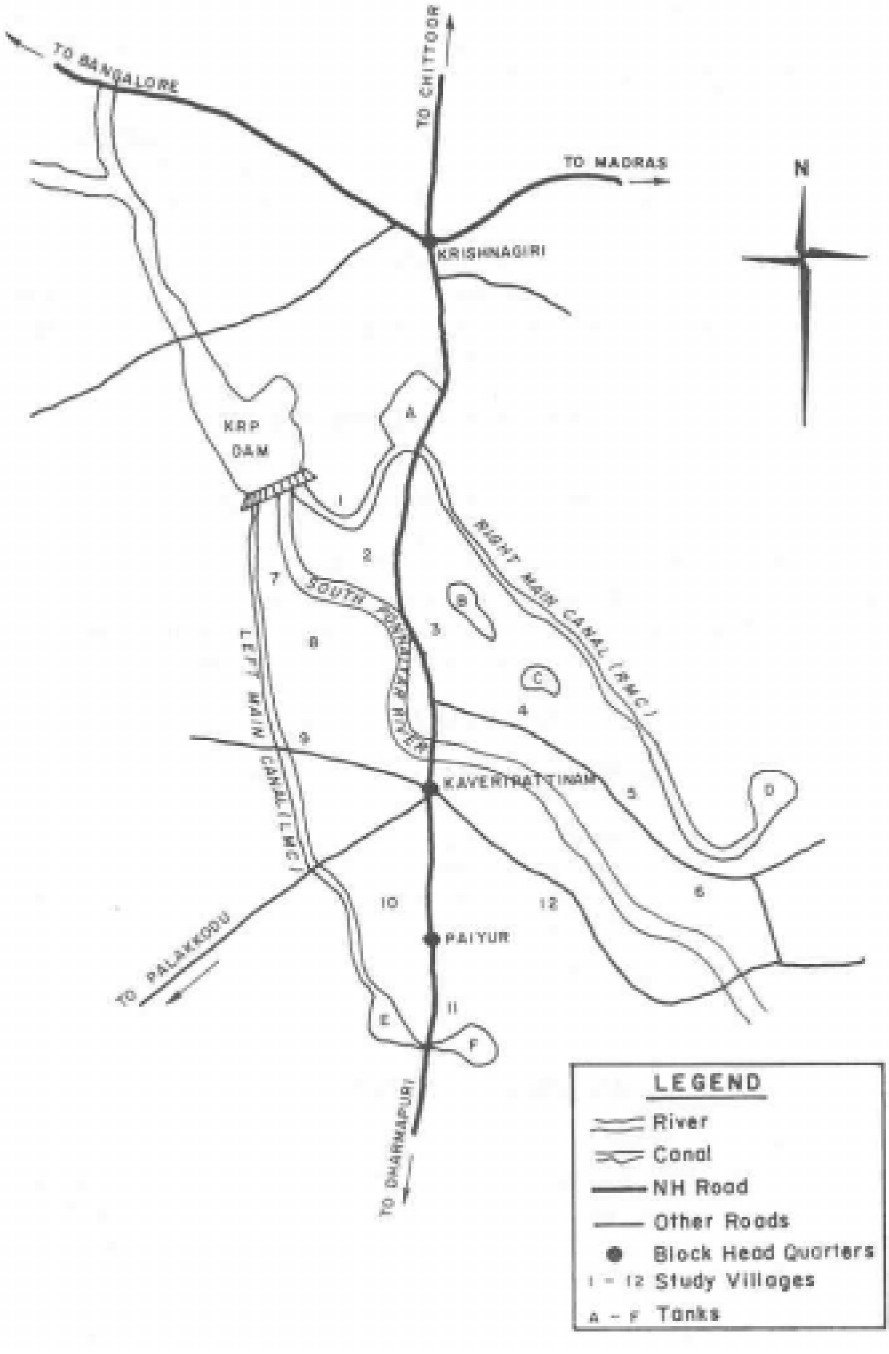

Figure 1. Index map of Krishnagiri Reservoir Project (Carte du Projet du Réservoir Krishnagiri)

left main canal (LMC) has a length of 18.20 km carrying a discharge of 2.83 cum. (100 cusecs). The registered ayacut area of LMC is 1913 ha (4724.73 acres). About 16 villages are benefitted by the reservoir.

The RMC has 9 distributaries and 17 direct sluices. The total length of the distributaries is 22.50 km. The LMC has 5 distributaries and 47 direct sluices.The length of the distributaries is 10.50 km. The total ayacut area localised under this project is 3649 ha (9012.20 acres) inclusive of 947 ha (2339.93 acres) irrigated by two PWD tanks and 24 minor irrigation tanks which are fed by KRP water. The Barur tank is fed by this river which has an ayacut area of about 1134 ha (2801.13 acres). The RMC feeds to 19 tanks and LMC to 7 tanks. The Thimmapuram tank is the biggest tank having an ayacut area of 222 ha (548.24 acres).

SOIL CHARACTERISTICS

The soil problem is one of the crucial factor that restricts the crop productivity in the ayacut area.The soil type in the KRP command area varies from sandy loam to clay loam in texture. The pH of the soil in the command area varies from 8.3 to 10.2. The organic content of the soil is found to be low. The available nitrogen status is low, while phosphorous is low to medium and potassium is medium to high. The physical properties, porespace, maximum water holding capacity and volume expansion ranges from medium to low.

DATA COLLECTION

The hydrometeorological parameters such as temperature, relative humidity, pan-evaporation, wind velocity were collected from the Regional Research station at Paiyur (TNAU) which is located at a distance of 5 km from the study area. The daily rainfall data (1960-1995) was collected from PWD rain gauge station located at the reservoir. The socio-economic details were collected from statistics department, Dharmapuri. The ayacut details, cropping pattern (1985-1995) details were collected from the PWD. The existing water-use details, mean yield details, fertilizer application details were collected from the Paiyur Research Station.

METHODS AND TECHNIQUES

In order to study the existing water distribution and cropping pattern of the study area, the data were collected from different sources. The existing pattern of water use and other inputs for paddy crop were collected from the Regional research station, Paiyur. The details of irrigation inputs were collected from the office of Public Works Department as secondary data.

The supply from the reservoir is usually allowed for five months duration. It was found that in KRP, normally water was let out during June and July for the first crop and December and January for the second crop. But since 1984 onwards, water was let out for irrigation from November to April only. The opening and closing of canals are based on the water availability in the reservoir. It was also observed that continous flow of supply is maintained in the canal system throughout the irrigation period. Due to this continous supply in the canals, the problem of unequal distribution of water exists among the farmers. The upper reach farmers use more water than the tail enders and so the water supply to the tail end areas of KRP ayacut was insufficient to meet the irrigation demands of the farmers in these areas.

From the data collected, the depth of existing water application is calculated using the release of water during the month of November to April. The depth of water application in the field would be also measured. The average depth of existing water application is calculated during the five month period. From this the existing weekly water application is calculated and used in this study as the real time values. The crop water demand was estimated using Pan-evoporation method.

SOIL WATER BALANCE MODEL

The simple conceptual model of soil water balance is presented in Figure 2. which monitors the soil moisture conditions at weekly intervals in an irrigation season by estimating the actual evoporation during any week and then carried over to the end of growth stage of the crop.

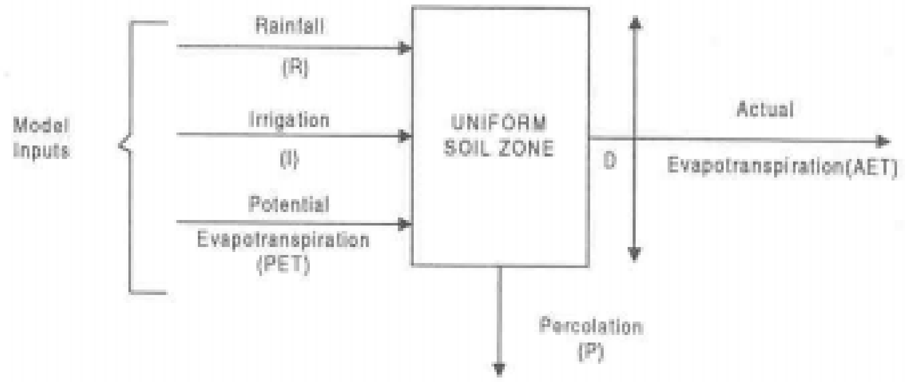

Figure 2. Conceptual model of soil water balance (Modèle conceptuel du bilan sol-eau)

The model is tested by applying the field conditions of the command area of Krishnagiri Reservoir Project, in order to determine the optimal water requirement for the paddy crop. The standard week is chosen as the time step of the model as it is a convenient interval for scheduling operations. The data inputs to the model are weekly values of rainfall R, irrigations applied I and evaporation. The output is the actual evapotranspiration AET during the week and the soil moiture content at the end of the week. The actual evapotranspiration is a function of both the available soil moisture and the atmospheric demand as part of the potential evapotranspiration PET. The available soil moisture varies with the depth of the crop rootzone D, rainfall R, irrigation I, deep percolation P, and actual evapotranspiration during the week under consideration. The following simplifying assumptions are made in the model :

(i) The depths of effective rainfall from discrete storm events occurring in the week, and irrigation applied, if any are lumped and assumed as input to the soil zone at the beginning of the week itself. All of this water infiltrates into the soil reservoir.

(ii) The soil column responds to water applications by reaching equilibrium instantaneously. The infiltrated water is redistributed uniformly over the effective rootzone, and the water, remaining in excess of the corresponding soil storage capacity, percolates out of the rootzone.

(iii) The effective depth D of the rootzone is constant for the week.

(iv) The contribution to soil moisture storage from capillary rise is negligible.

A program developed in C language is used in this analysis.

Based on the assumptions listed above, the water balance in the effective rootzone on i^{th} day of the k^{th} week is given as :

$$q_{ik}Dk = q_{i-1,k} D_k - AET_{ik}; \; i = 1,7$$

$$q_{i-1,k} D_k = q_{7,k-1} D_{k-1} + R_k + I_k - P_k + q_o(D_k - D_{k-1})$$

where

$q_{ik} D_k$	=	Soil moisture at the end of i^{th} day of k^{th} week in mm.
$q_{7,k-1} D_{k-1}$	=	Soil moisture at the end of seventh day of (k-1) week in mm.
$q_{i-1,k} D_k$	=	Soil moisture at the beginning of i^{th} day or the end of previous day of k^{th} week in mm.
R_k	=	Rainfall during k^{th} week in mm.
I_k	=	Irrigation during k^{th} week in mm.
AET_{ik}	=	Actual evapotranspiration during i^{th} day of the k^{th} week in mm.
D_k	=	Effective depth of root zone during k^{th} week in mm.
P_k	=	Percolation below rootzone which is given by $R_k + I_k - (FC - q_{7,k-1}) D_{k-1}$; if $R_k + I_k > (FC - q_{7,k-1}) D_{k-1}$
P_k	=	0; otherwise

FORECASTED WEEKLY RAINFALL

The soil water balance model requires forecasting of weekly rainfall for the analysis. The autoregressive model was used for forecasting weekly rainfall. The weekly rainfall values for a period of 35 years (1960-1995) were taken for analysis. The residual mass curve analysis was done for investigating the wet and dry periods of KRP as depicted in Figure 3. The comparison of actual and forecasted rainfall for the year 1995 was done and observed that the forecasted rainfall follows the trend of actual rainfall.

STRATEGIES FOR CONTROLLED WATER SAVING METHOD

The strategies adopted in this study for controlled water saving method is based on the suitability and practicability of the present research. By knowing the soil moisture in each growth stage of the crop, the crop stress can be reduced at critical stages thus preventing the excess water application. This method of controlling the application of water quantitatively for each and every stage of paddy crop yields a solution to support the present study in a different and new approach for effective saving of water.

There are five growth stages in paddy crop. In the establishment stage, the water requirement is less. In fact, if the seeds are submerged, the development of radicles will be affected by the lack of oxygen supply. Hence very minimum amount of water is required. The production of an adequate number of tillers is an important factor in rice yields. So immediately, after transplanting sufficient water should be provided to facilitate early rooting. Following the early rooting stage shallow water depth facilitates tiller production and promotes firm anchorage in the soil. Excessive water at this stage hampers rooting and decreases tiller production. If the plants are submerged they become weak, turn light green and break easily. The rice crop shows marked sensitivity to moisture stress during the formation of reproductive organs and during flowering and water stress at this stage causes severe damage. Hence this stage requires more water. In the ripening stage, very small quantity of water is needed and after the yellowish ripening stage, no standing water is required. Hence the most critical stages are active tillering the flowering stages.

In order to find optimum soil moisture by determining the optimum irrigation depth, different level of irrigations would be given to the model until the soil moisture reaches the optimum moisture so that the actual evapotranspiration is equal to the potential evapotranspiration. The optimal irrigation requirement is the amount of water exclusive of precipitation required for crop production. In other words, it is the amount of irrigation water that must be stored in the rootzone to meet the consumptive use requirement of a crop.It is a function of (i) soil type (ii) extending of roots into the soil (iii) the allowable water depletion (iv) the existing soil water content and (v) rainfall. This method of irrigation, called

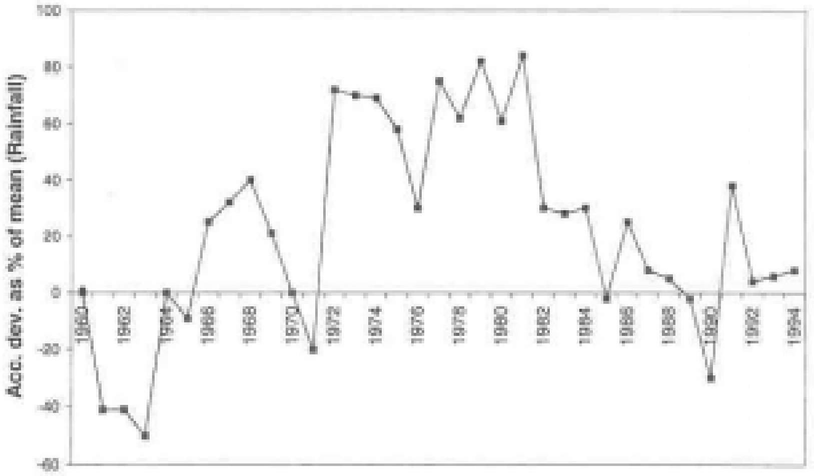

Figure 3. Residual mass curve analysis (Analyse de la courbe des valeurs cumulées résiduelles)

'controlled water-saving method', saves water by reducing surface runoff and percolation losses and also increases the amount of rainfall that is used effectively.

For paddy crop, the initial rooting depth at the time of planting is taken as 5.0 cm and the effective rooting depth is taken as 60 cm. The field capacity is taken as 2 mm/cm depth for clay loam soil, which is the soil type in the study region. The depletion of available soil moisture was allowed except at two stages. The most critical stages are active tillering and the flowering stages. The field capacity is maintained as the upper limit for non-critical stages and it is maintained as the lower limit for critical stages and 10 mm is supplied every day throughout the growth stage. The amount of rainfall which is useful to refill the soil profile to its field capacity is considered as the effective rainfall.

RESULTS AND DISCUSSION

Real time, optimal soil moisture and irrigation depth

The existing irrigation application known as the real time values was given to the model and the results obtained from the model such as soil moisture and AET at the end of the week as well as at the end of each growth stage of three different types of paddy and the results of optimum irrigation requirement to meet the consumptive use of a crop are presented in Tables 1, 2, 3, 4, 5 and 6 respectively. The comparison between the existing and the optimum results are shown in the Figures 4, 5 and 6 respectively.

Table 1. Soil moisture and aet for short duration paddy at the end of each week (Humidité du sol et AET pour le paddy de courte durée à la fin de chaque semaine)

Crop : Paddy

Planting date : November 25
Harvesting date : March 3
Total crop period : 100 days

Week No.	Real time results			Optimal results			PET in 'mm'
	Soil moisture (qD) in 'mm'	AET in 'mm'	Depth of irrigation applied in 'mm'	Soil moisture (qD) in 'mm'	AET in 'mm'	Depth of irrigation applied in 'mm'	
1	8.45	4.24	85	2.51	4.24	35	4.24
2	25.20	3.64	85	6.32	3.64	30	3.64
3	41.51	4.44	85	25.17	4.44	30	4.44
4	47.95	4.74	85	30.97	4.74	70	4.74
5	58.59	4.86	85	39.07	4.86	70	4.86
6	66.12	4.45	85	48.76	4.45	70	4.45
7	53.85	4.80	85	44.42	4.80	30	4.80
8	93.97	5.07	85	55.64	5.07	70	5.07
9	87.37	5.20	85	61.70	5.20	70	5.20
10	89.91	5.24	85	76.58	5.24	70	5.24
11	86.03	5.06	85	68.99	5.06	70	5.06
12	83.00	5.08	85	66.00	5.08	30	5.08
13	73.12	5.24	85	54.25	5.24	25	5.24
14	66.61	5.70	85	50.58	5.70	20	5.70

Depth of existing water application = 1190 mm
Depth of optimal irrigation = 690 mm

It could be seen from the tables that the existing irrigation application of three different paddy crops is always in excess quantities when compared to the optimum requirement. The optimum results have been obtained by satisfying the condition AET = PET highlighting that the actual consumptive use of the crop is satisfied. When AET falls below PET, the crop will be under water stress. The optimal water requirement is 135, 200, 10,300 and 55 mm where as the depth of existing irrigation application is 303.57, 242.85 60.72, 364.28 and 218.58 mm in establishment, active tillering, vegetative lag period, flowering and ripening stages, respectively for short duration paddy. The optimal water requirement is 135, 300, 62.14, 350 and 80.86 mm whereas the depth of existing irrigation is

Table 2. Soil moisture and aet for medium duration paddy at the end of each week (Humidité du sol et AET pour le paddy de moyenne durée à la fin de chaque semaine)

Crop	:	Paddy	Planting date	: November 20
			Harvesting date	: April 2
			Total crop period	: 135 days

Week No.	Real time results			Optimal results			PET in 'mm'
	Soil moisture (qD) in 'mm'	AET in 'mm'	Depth of irrigation applied in 'mm'	Soil moisture (qD) in 'mm'	AET in 'mm'	Depth of irrigation applied in 'mm'	
1	7.59	4.17	85	1.65	4.17	35	4.17
2	18.08	4.21	85	6.27	4.21	30	4.21
3	31.94	3.80	85	15.60	3.80	30	3.80
4	45.35	4.57	85	28.37	4.57	70	4.57
5	58.76	4.60	85	39.24	4.60	70	4.60
6	64.39	4.91	85	47.03	4.91	70	4.91
7	59.07	4.42	85	50.27	4.42	70	4.42
8	73.01	4.92	85	63.58	4.92	30	4.92
9	85.83	4.98	85	59.96	4.96	28	4.92
10	64.52	4.98	85	51.19	4.98	25	4.98
11	77.83	5.26	85	60.29	5.26	70	5.26
12	84.51	5.29	85	67.51	5.29	70	5.29
13	90.17	5.62	85	71.30	5.62	70	5.62
14	80.42	5.60	85	64.39	5.60	70	5.60
15	73.37	6.07	85	56.77	6.07	70	6.07
16	71.04	6.28	85	52.55	6.28	35	6.28
17	72.09	6.04	85	48.19	6.04	32	6.04
18	72.10	6.29	85	46.94	6.29	28	6.29
19	64.41	6.58	85	35.18	6.58	25	6.58

Depth of existing water application = 1147.99 mm
Depth of optimal irrigation = 928 mm

Table 3. Soil moisture and aet for long duration paddy at the end of each week (Humidité du sol et AET pour le paddy de longue durée à la fin de chaque semaine)

Crop : Paddy

Planting date : November 28
Harvesting date : April 7
Total crop period : 140 days

Week No.	Real time results			Optimal results			PET in 'mm'
	Soil moisture (qD) in 'mm'	AET in 'mm'	Depth of irrigation applied in 'mm'	Soil moisture (qD) in 'mm'	AET in 'mm'	Depth of irrigation applied in 'mm'	
1	8.37	4.68	84	2.43	4.68	35	4.68
2	21.40	4.87	84	9.59	4.87	30	4.87
3	35.73	4.43	84	19.39	4.43	30	4.43
4	48.85	4.83	84	31.87	4.83	70	4.83
5	58.14	5.17	84	38.62	5.17	70	5.17
6	57.58	5.50	84	40.22	5.50	70	5.50
7	67.07	5.52	84	57.64	5.52	70	5.52
8	91.19	5.88	84	52.86	5.88	30	5.88
9	65.79	5.60	84	39.92	5.60	30	5.60
10	39.13	5.96	84	25.80	5.96	28	5.96
11	47.69	6.28	84	30.65	6.28	30	6.28
12	43.81	6.68	84	26.81	6.68	30	6.28
13	49.03	6.69	84	30.16	6.69	70	6.69
14	53.32	6.82	84	37.49	6.82	70	6.82
15	71.82	7.28	84	45.22	7.28	70	7.28
16	88.51	7.09	84	56.02	7.09	70	7.09
17	73.56	6.50	84	42.66	6.50	70	6.50
18	69.56	6.71	84	38.66	6.71	35	6.71
19	81.88	6.46	84	50.98	6.46	34	6.46
20	73.39	6.44	84	45.49	6.44	30	6.44

Depth of existing water application = 1680 mm
Depth of optimal irrigation = 972 mm

Table 4. Soil moisture and aet for short duration paddy at the end of each growth stage (Humidité du sol et AET pour le paddy de courte durée à la fin de chaque stade de croissance)

Crop : Paddy

Planting date : November 25
Harvesting date : March 3
Total crop period : 100 days

Growth stages	Real time results			Optimal results			PET in 'mm'
	Soil moisture (qD) in 'mm'	AET in 'mm' 'mm'	Depth of irrigation applied in 'mm'	Soil moisture (qD) in 'mm'	AET in 'mm'	Depth of irrigation applied in 'mm'	
Etablishment	102.56	4.61	303.57	51.69	4.61	135	4.61
Active tillering	152.95	4.60	242.85	120.00	4.60	200	4.60
Vegetative lag period	56.83	4.83	60.72	39.03	4.83	10	4.83
Flowering	246.68	5.07	364.28	120.00	5.07	300	5.07
Ripening	64.41	4.90	218.58	50.58	4.90	55	4.90
Total			1190.00			690	

Depth of existing water application = 1190 mm
Depth of optimal irrigation = 690 mm
Amount of water saved = 500 mm

Table 5. Soil moisture and aet for medium duration paddy at the end of each growth stage (Humidité du sol et AET pour le paddy de moyenne durée à la fin de chaque stade de croissance)

Crop : Paddy

Planting date : November 20
Harvesting date : April 2
Total crop period : 135 days

Growth stages	Real time results			Optimal results			PET in 'mm'
	Soil moisture (qD) in 'mm'	AET in 'mm' 'mm'	Depth of irrigation applied in 'mm'	Soil moisture (qD) in 'mm'	AET in 'mm'	Depth of irrigation applied in 'mm'	
Etablishment	83.52	4.75	303.57	39.73	4.75	135.00	4.75
Active tillering	276.38	4.90	363.43	120.00	4.90	300.00	4.90
Vegetative lag period	78.85	5.15	243.71	60.29	5.15	62.14	5.15
Flowering	303.46	6.14	425.00	120.00	6.14	350.00	6.14
Ripening	64.41	6.65	112.28	33.51	6.05	80.86	6.05
Total			1447.99			928.00	

Depth of existing water application = 1447.99 mm
Depth of optimal irrigation = 928 mm
Amount of water saved = 519.99 mm

Table 6. Soil moisture and aet for long duration paddy at the end of each growth stage (Humidité du sol et AET pour le paddy de longue durée à la fin de chaque stade de croissance)

Crop : Paddy

Planting date : November 20
Harvesting date : April 2
Total crop period : 135 days

Growth stages	Real time results			Optimal results			PET in 'mm'
	Soil moisture (qD) in 'mm'	AET in 'mm' 'mm'	Depth of irrigation applied in 'mm'	Soil moisture (qD) in 'mm'	AET in 'mm'	Depth of irrigation applied in 'mm'	
Etablishment	93.41	4.65	300.00	49.62	4.65	135	4.65
Active tillering	264.24	5.84	360.00	120.00	5.84	300	5.84
Vegetative lag period	49.03	6.42	420.00	30.16	6.42	143	6.42
Flowering	275.36	6.75	360.00	120.00	6.75	300	6.75
Ripening	73.39	7.30	240.00	45.49	7.30	94	7.30
Total			1680.00			972	

Depth of existing water application = 1680 mm
Depth of optimal irrigation = 972 mm
Amount of water saved = 708 mm

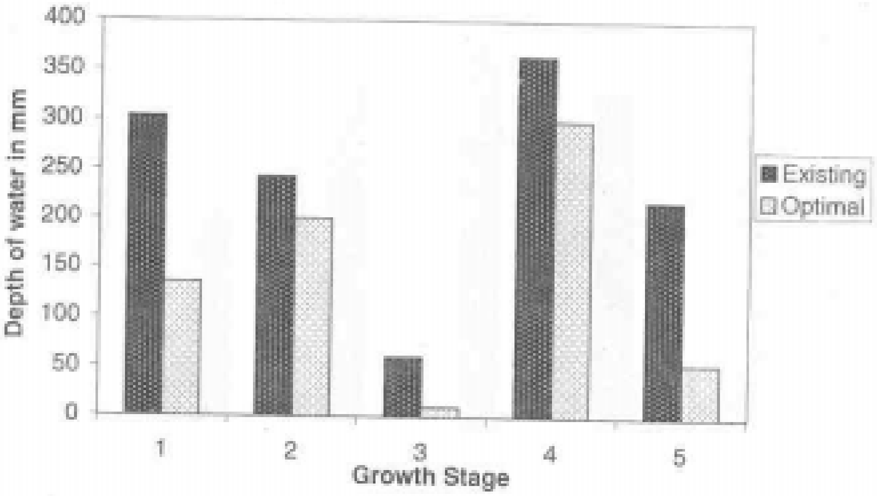

Figure 4. Comparison of existing and optimal irrigation for short duration paddy (Comparaison entre l'irrigation actuelle et l'irrigation optimale pour le paddy de courte durée)

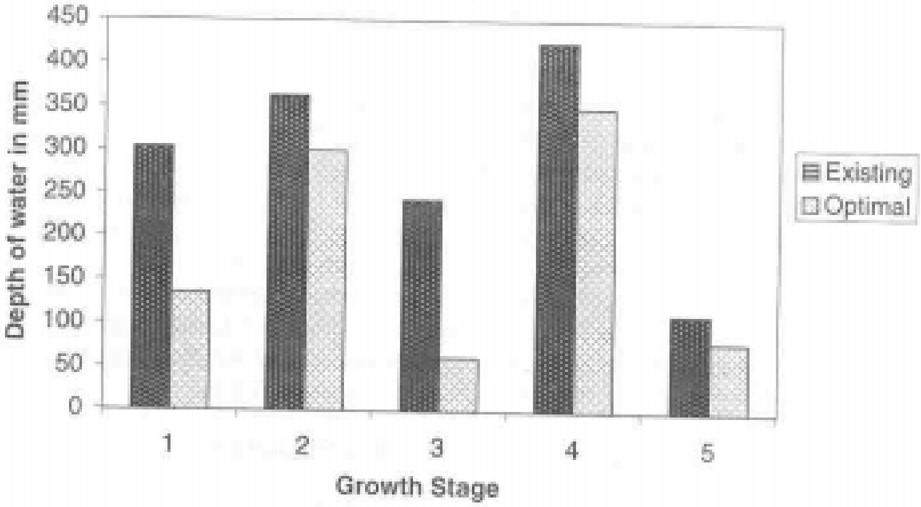

Figure 5. Comparison of existing and optimal irrigation for medium duration paddy (Comparaison entre l'irrigation actuelle et l'irrigation optimale pour le paddy de moyenne durée)

303.57, 363.43, 243.71,425 and 112.28 mm in establishment, active tillering, vegetative lag period flowering and ripening stages respectively for medium during paddy. The optimal water requirement is 135, 300, 143,300 and 94 mm whereas the depth of existing irrigation is 300, 360, 420, 360 and 240 mm

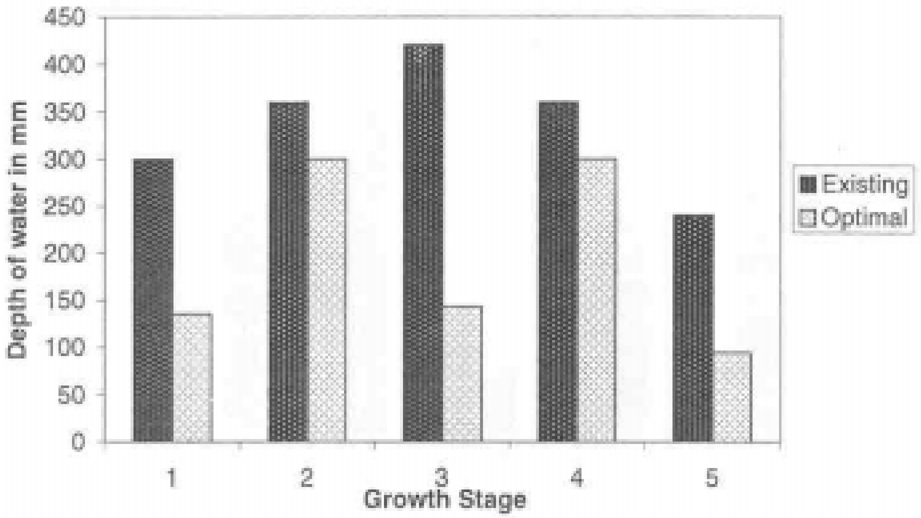

Figure 6. Comparison of existing and optimal irrigation for long duration paddy (Comparaison entre l'irrigation actuelle et l'irrigation optimale pour le paddy de longue durée)

respectively in establishment active tillering, vegetative lag period, flowering and ripening stages for long duration paddy.

The optimal water requirement is 690, 928 and 972 mm whereas the depth of existing irrigation application is 1190,1447.99 and 1680 mm for short, medium and long duration paddy varieties. Hence by giving optimum irrigation, 500 mm, 519.99 and 708 mm of water could be saved for short, medium and long duration paddies respectively. By adopting optimum irrigation, about 42%, 36% and 42% savings of water could be done for short, medium and long duration paddies respectively. If irrigation decisions are made based on this method, it is clear that more amount of water could be saved and this amount of water could be used to irrigate more areas additionally. The comparison of existing and optimal irrigation for all the three varieties is shown in Figure 4,5 & 6.

OPTIMUM IRRIGATION SCHEDULING

Optimum irrigation scheduling for short, medium and long duration paddies was carried out using the condition AET=PET. The soil moisture is calculated everyday. The end of first day soil moisture is used for the beginning of next day soil moisture. The value of AET for that day is subtracted from the soil moisture. If the soil moisture is not sufficient, (ie) when AET reduces, irrigation is applied and this process is carried out continuously. Scheduling is done for three non-critical stages namely establishment, vegetative lag period and ripening stages respectively and presented in Tables 7, 8 and 9. For critical stages, 10 mm/day is applied continuously throughout the period.

Table 7. Optimum irrigation scheduling for short duration paddy (Plan d'irrigation optimale pour le paddy de courte durée)

Days	Establishment Stage (mm)			Vegetative lag period (mm)			Ripening Stage (mm)			
	I Week	II Week	III Week	I Week	II Week	III Week	I Week	II Week	III Week	IV Week
Mon	10	-	-	-	-	-	-	-	-	10
Tues	-	10	-	10	-	-	7	10	5	-
Wed	10	-	-	-	10	10	7	5	5	5
Thurs	-	10	15	10	-	-	7	5	10	10
Fri	10	-	-	-	10	10	3	6	-	-
Sat	-	-	-	10	-	5	3	5	5	-
Sun	5	10	15	-	8	-	6	-	3	-

Table 8. Optimum irrigation scheduling for medium duration paddy (Plan d'irrigation optimale pour le paddy de moyenne durée)

Days	Establishment Stage (mm)			Vegetative lag period (mm)					Ripening Stage (mm)		
	I Week	II Week	III Week	I Week	II Week	III Week	IV Week	V Week	I Week	II Week	III Week
Mon	10	-	-	-	-	-	-	10	10	-	-
Tues	-	-	-	10	10	5	10	-	-	7	10
Wed	10	10	10	-	-	10	-	10	10	7	-
Thurs	-	-	-	10	10	-	10	-	-	5	10
Fri	10	10	10	-	-	5	-	5	10	7	-
Sat	-	-	-	10	10	5	5	-	-	5	10
Sun	5	10	10	-	-	5	5	-	5	4	-

DEVELOPMENT OF KNOWLEDGE BASE

A knowledge base is created with the suggestions and opinions of experts consulted in the study area. The knowledge base incorporates all the domain -

Table 9. Optimum irrigation scheduling for long duration paddy (Plan d'irrigation optimale pour le paddy de longue durée)

Days	Establishment Stage (mm)			Vegetative lag period (mm)	Ripening Stage (mm)		
	I Week	II Week	III Week		I Week	II Week	III Week
Mon	10	-	-	-	-	-	-
Tues	-	15	-	10	10	-	5
Wed	10	-	-	-	-	10	5
Thurs	-	-	15	10	10	-	5
Fri	15	-	-	-	-	10	5
Sat	-	-	-	10	10	-	-
Sun	-	15	15	-	-	5	-

specific knowledge which can be modified or deleted and new knowledge added. This knowledge base is the true representation of the expertise required for adopting controlled water saving method in the field. About 30 experts have been consulted for discussion and collecting informations with the help of a questionnaire. The acquired knowledge from these experts have been incorporated in a set of IF.. THEN rules. These rules if framed properly would be used for developing an expert system for practicing the controlled water saving method in the field.

CONCLUSIONS

The study revealed that the existing irrigation water application is in excess quantities than the optimum water requirement. This study proposes a new method of irrigating paddy crop especially for farmers in the Krishnagiri Reservoir project, Dharmapuri to save the excess amount of water. The controlled water saving irrigation has properties such as water saving, high- yield, high-quality, low consumption of water, adaptability for heavy manuring and resistance to lodging. By adopting this method, the study reveals that 500 mm (42%) , 519.99 mm (36%) and 708 mm (42%) of water could be saved for short, medium and long duration paddy varieties. The optimum irrigation scheduling is done for short, medium and long duration paddy varieties for each growth stage of the crop. In each growth stage, it is scheduled on weekly basis. A knowledge base is developed which would yield an Expert System for implementing the controlled water saving method. By adopting this method water can be evenly distributed to the farmers.

This method not only reduces the excess amount of water application but also changes the prevalent practice of adopting standing water in the fields. More area could be irrigated with the amount of saved water by using this method. By this method, the leaf transpiration, interplant evaporation and field seepage can be greatly reduced.

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N.D. Gulhati
(1904–1978)

Late President Honoraire N.D. Gulhati was born in Lahore (Pakistan) on 15 November 1904. He took his technical education at the Thomson Civil Engineering College, Roorkee (Now University of Roorkee) and passed out with honours in 1926. He was appointed to the Indian Service of Engineers in October in 1927 and posted to the Irrigation Branch of the Public Works Department, Punjab. From August 1945 to March 1949, he was Secretary of the Central Board of Irrigation and Power.

In 1950 he was responsible as the Chief of the Natural Resources Division in the Planning Commission, Government of India, for initiating proposals relating to the development of irrigation and power, soil conservation and mineral development in the First Five-Year Plan. He was made Chief Engineer and Joint Secretary in 1953 and Additional Secretary to Government of India in 1958. From 1952 until the Indus Waters Treaty was concluded in 1960 (and ratified in 1961), Mr. Gulhati was India's Chief Representative on the Indus Waters negotiations conducted under the aegis of IBRD. He represented India in many international engineering conferences.

He was awarded the high distinction of 'PADMA BHUSHAN' of India in 1961 "for distinguished services of a high order".

After retirement President Honoraire Gulhati worked as Water Resources Consultant to many State Governments in India and as Consultant to IBRD (1963), as Consultant to the International Development Association (1963-1973), and as Consultant to United Nations (Economic Commission for Asia and Far East, now ESCAP) in 1969.

He has been rightly called the "Father" of the International Commission on Irrigation and Drainage, as it was he who conceived this organization. The proposal of setting up of the Commission was mooted to the Government of India by him in 1946. The Commission was set up in the year 1950 and Mr. Gulhati was elected as its first Secretary General. He served ICID as founder Secretary General from 1950 to 1957, as Vice President from 1957 to 1960, and as President Hon. 1960 to 1963.

Besides engineering and scientific papers contributed to the national institutes (e.g. Punjab Engineering Congress; Institution of Engineers, India) and the American Society of Civil Engineers, Mr. Gulhati had some 20 books and publications to his name.

Mr. Gulhati was always amongst the foremost supporters of ICID and did everything possible to promote the objects of ICID. He was the founder Editor of the ICID Bulletin. He was responsible for getting the land of the office building of the Central Office of the Commission in the prestigious Diplomatic Enclave. His mature leadership, dynamic personality and diplomatic and adroit handling of the matters won him universal respect and endearment with all the members of the International Executive Council.

The "N.D. Gulhati Memorial Lecture for International Cooperation in Irrigation" delivered at each ICID Congress since 1981 has since been converted into 'N.D. Gulhati Memorial International Award for the best paper contributed to an ICID Congress by a young professional" with effect from the Cairo Congress, 1996.

This has been at the instance of Later Mr. N.D. Gulhati's family, represented by his son Late Dr. Ravi Gulhai and now by Mrs. Kaval Gulhai, in conformity with ICID's objective to encourage young professionals in irrigation and drainage.

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