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水稻灌溉之最小渠道容量

Minimizing Canal Capacity for Irrigated Rice

溫　　理　　仁

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The writer wishes to express his appreciation to the authors for their efforts to improve the formulas used in Taiwan for determining canal capacity for irrigated rice.

In 1964, the writer derived two formulas for minimizing canal capacity for irrigted rice, Eq. 4 and Eq. 25:

$$Q=\frac{ADt}{\left[1-\left(\frac{Ds}{Ds+SDt}\right)^{n}\right](1-L)} \quad \cdots\cdots (25)$$

Later in 1971, Cheng improved Eq. 25 and gave the following formula:

$$Q=\frac{ADt}{\left[1-\left(\frac{Ds-\frac{1}{2}SDt}{Ds+\frac{1}{2}SDt}\right)^{n}\right](1-L)} \quad \cdots\cdots (26)$$

in which all the symbols have the same significance as given by the authors.

The authors' formula is identical to Eq. 25 and Eq. 26 except that the maintenance water is or is not supplied during the first rotational irrigation period of S. This derivation method of the authors' formula is also identical to that of Eqs. 25 and 26 when the same mathematical expression is used. Hagan consulted the writer about this problem in Taipei in April 1975 in working for the former's M. S. thesis. The authors' formula may be discussed in comparison with the other three as follows:

1. The authors' assumption that the maintenence water is not supplied during the first rotational period is not practical. Actually in the field, the maintenance water is even greater especially in the initial stage of land soaking as percolation is serious, than in the period after transplanting when the soil is puddled into a

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plastic state that gives a minimum percolation loss. Without maintenance water, the field will be soon unworkable for land preparation (plowing, harrowing, puddling, and leveling) Theoretically speaking, the water Ds required for soaking the soil of the root zone is kept in the field as the maintenance water Dt is supplied to replenish the water losses, so that the farmers have enough water to puddle their individual fields and transplant rice at any time, within the period of N days. Therefore, in comparison with Eq. 6 in the authors' paper, Eq. 25 includes an additipnal amount of maintenance water a_{ij} Dt in the daily water requirement Q_{ij} as follows:

$$Q_{ij}=\alpha_{ij}\ Ds+\sum_{i=1}^{i}\sum_{j=1}^{s}(a_{jj}\ Dt) \qquad (27)$$

and Eq. 26 adds $1/2\Sigma_s^{j=1}$ $(a_{ij}Dt)$ of maintenance water on the average for a short period of i as follows:

$$Q_{ij}=\alpha_{ij}\ Ds+\frac{1}{2}\sum_{j=1}^{s}(a_{ij})+\sum_{j=1}^{i-1}\sum_{i=1}^{s}(a_{ij}Dt) \qquad (28)$$

2. In the actual field operation of land preparation for rlce transplanting, the farmers have flexibility of starting puddling and transplanting after receiving irrigation water to be simultaneously delivered to all fields. The length of time between the delivery of the water and transplanting may be a few days or as much as 30 days in some parts of the world, depending on the soil, water and climatic conditions, the habits of farmers, crop variation, cropping patterns, farm mechanization, the availability of farming labor, etc. This time period is uncertain and different among farmers even in the same irrigation district, simply because of difference in labor shortage for instance. If transplanting machines are used, not only irrigation but also drainage is required. Since the irrigation pattern

TABLE 1.—Comparisonof Rotation Units for Four Formulas

Formula (1)	Items (2)	First 5-day psriod i=1 (3)	Second 5-day period i=2 (4)	Third 5-day period i=3 (5)	Fcurth 5-day period i=4 (6)	Total area, in hectares (7)
Eq. 24	$\sum_{j=1}^{s} a_{ij}$	37.50	27.50	20.20	14.79	100
	a_{ij}	7.50	5.50	4.04	2.96	
Eq. 4	$\sum_{j=1}^{s} a_{ij}$	35.67	27.36	20.93	16.04	100
	a_{ij} (average)	7.13	5.47	4.19	3.21	
Eq. 25	$\sum_{j=1}^{s} a_{ij}$	34.40	27.20	21.45	16.95	100
	a_{ij}	6.88	5.44	4.29	3.39	
Eq. 26	$\sum_{i=1}^{s} a_{ij}$	35.75	27.35	20.90	16.00	100
	a_{ij}	7.15	5.47	4.18	3.20	

Note: $\sum_{j=1}^{s} a_{ij}$ = the area of the rotation unit i, supplied with irrigation water in individual period of S=5 days. a_{ij}=Watersupply rate, in hectares per day, for land soaking.

during the period of N is quite different from that of the transplanted field, the rotational irrigation as suggested by the authors is not practical during the period of land preparation and transplanting. The authors' formula has the defect that when N becomes large, the area of a rotation unit supplied with irrigation water becomes even smaller than that of the other three formulas. With the same conditions of the numerical example as shown in the authors' paper, the calculated results for the four formulas are listed in Table 1 for comparison.

3. With reference to Eq. 6 of the authors' formula was not derived on the basis of rotational irrigation. As a result. there would be different size of rotation units which are not consistent to the actual field conditions. In this respect, Eq. 4 has advantage to fit in the desirable size of each rotation unit by adjusting the value of individual S. For the same example (assuming there are four rotaion units' each 25 ha in size), Eq. 4 gives the following figures:

	First period	Second period	Third period	Fourth period	Total area, in hectares
Rotationunit, in hectares	25	25	25	25	100
Adjusted S, in days	3.36	4.09	5.24	7.30	