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Short Note

Simulation modelling of canal irrigated command area: A case study

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Abstract
The present study was carried out to assess existing and alternative water supply and demand scenarios of the Nawagarh Distributary of Hasdeo Bango Irrigation Project, Chhattisgarh, India. The selected model uses the FAO (1992) Penman-Montieth method for calculating the reference crop evapotranspiration. These estimates are used in crop water requirements and irrigation scheduling calculations. In this study, assessing the supply and demand scenario for the summer rice and alternative *rabi* crops (considering three most commonly grown crops is wheat, gram and sunflower). The seasonal applied canal water depth during the study period was about 112.52% (2012) and 138.25% (2013) more than the seasonal demands for the served area (SA). Therefore, more area can be brought under summer rice cultivation. The model estimated irrigation requirement for summer rice was in close agreement with the experimentally determined value of the region and thus, the selected model can be used as a tool for determining stagger irrigation requirement.

Keywords: command area, CROPWAT, irrigation scheduling, simulation modelling, water supply-demand

Introduction
Irrigation Scheduling involves deciding when and how much water to apply to a field. Good scheduling will apply water at the right time and in the right quantity in order to optimize production and minimize adverse environmental impacts. Bad scheduling will mean that either not enough water is applied or it is not applied at the right time, resulting in under-watering, or too much is applied or it is applied too soon resulting in over-watering. Under or overwatering can lead to reduced yields, lower quality and inefficient use of nutrients. "CROPWAT 8.0" is a decision support system developed by the Land and Water Development Division of Food and Agricultural Organization (FAO) for planning and management of irrigation system. It is a practical tool to carry out reference evapotranspiration, crop water requirements and crop irrigation requirements, and more specifically the design and management of irrigation schemes. It allows the development of recommendations for improved irrigation practices through the planning of irrigation schedules under varying water supply conditions. For the study purpose Nawagarh Distributary (Block-Nawagarh, District- Janjgir-Champa) of Hasdeo Bango Major Irrigation Project (District- Janjgir-Champa) of Chhattisgarh is selected.

Materials and Methods
Study Area
The Hasdeo Bango Irrigation Project is one of the largest projects in the state of Chhattisgarh, India that provides irrigation facilities to about 2, 55,000 ha in 801 villages of 3 districts (Korba, Janjgir-Champa, and Raigarh) and also generates 120 MW hydel power. The *kharif* rice occupies 100% of the available cultural command area but in the *rabi* season, the occupied area varies according to the availability of water in the reservoir. Nawagarh Distributary (R.D. 22430 m of Janjgir Branch Canal) is selected for the present study, which lies in latitude of 22°19'35" N and longitude of 81°59'50" E. The distributary covers 32 villages of Nawagarh block of Janjgir-Champa district with the length 22.86 km consisting of 9 sub-distributaries and 39 minors. The design discharge of the distributary is 10.89 m^3/s.

Collection of Data
The data on weather, crop; soil and canal flow pertaining to the study area were collected from

various state government departments/agencies like water resources, agriculture, agricultural research station and from personal contact with farmers of the command area for the study year 2012 and 2013.

Table 1: Operational status of Nawagarh distributary

Year	Canal				Water	Area (ha)		Water	Avg. rice
	Open	Close	Run	Avg. disch-arge	supply	Targeted	Served	supply depth	yield
			(days)	(m^3/s)	(Mm^3)			(cm)	(kg/ha)
2012	Jan, 2	May, 8	128	8.05	89.03	4444.91	4000.52	200	4044
2013	Jan, 9	May, 12	124	8.43	90.34	3978.13	3478.13	227	3622
Avg.			126	8.24	89.69	4211.52	3739.33	214	3833

***Source*:** Department of Water Resources, Government of Chhattisgarh, India.

Assessment of demand - supply gap of an irrigated command

For estimation of Demand-Supply gap, the following equation is used:

$$\text{Demand-Supply gap} = \sum \text{Supply} - \sum \text{TID}$$

Supply and demand scenario for summer rice

The supply and demand scenario of Nawagarh distributary for summer rice for both the study year 2012 and 2013 for actual served area was obtained by using MS excel. Daily canal supply from the Nawagarh Distributary source was compared with the daily total irrigation demand (TID) for assessing supply-demand gap scenario of the summer rice.

Results and Discussion

Estimation of demand-supply gap of the canal system

Daily water supply and demand at the supply system source of summer rice for the served area during study year 2012 and 2013 are shown in Figure 1. It is evident that the supply was more than the demand in most of the days. Only for a few days, the supply was less than the demand. The water supply-demand pattern of summer rice for the served area of the Nawagarh Distributary is shown in Table 2. The served area was 4000.52 and 3478.13 ha in the years 2012 and 2013, respectively, whereas the water delivered were 91.45 and 90.34 Mm^3 in the years 2012 and 2013, respectively. The applied depth of water (estimated from columns 1 and 2 of Table 2) were 228.59 and 259.75 cm in the years 2012 and 2013, respectively. On seasonal depth basis, the water delivered (228.59 cm in 2012 and 259.75 cm in 2013) was in excess of the demand (107.60 cm in 2012 and 109.02 cm in 2013). It is also evident from Table 2 (column 5) that the supply was 112.52% (2012) and 138.25% (2013) higher than the demand. This is also reflected in the water management indices (WMI) in column 6.

Table 2: Water supply and demand pattern for summer rice in the served area of the Nawagarh Distributary

Year	Served area (ha)	Supply (CF) (Mm^3)	Demand (TID) (Mm^3)	Excess (+ve) deficit (-ve) (Mm^3)	Excess over demand (%)	WMI (CF/TID)
	(1)	(2)	(3)	(4)	(5)	(6)
2012	4000.52	91.45	43.03	48.42 (+ve)	112.52	2.13
2013	3478.13	90.34	37.92	52.42 (+ve)	138.25	2.38

WMI = Water Management Indices

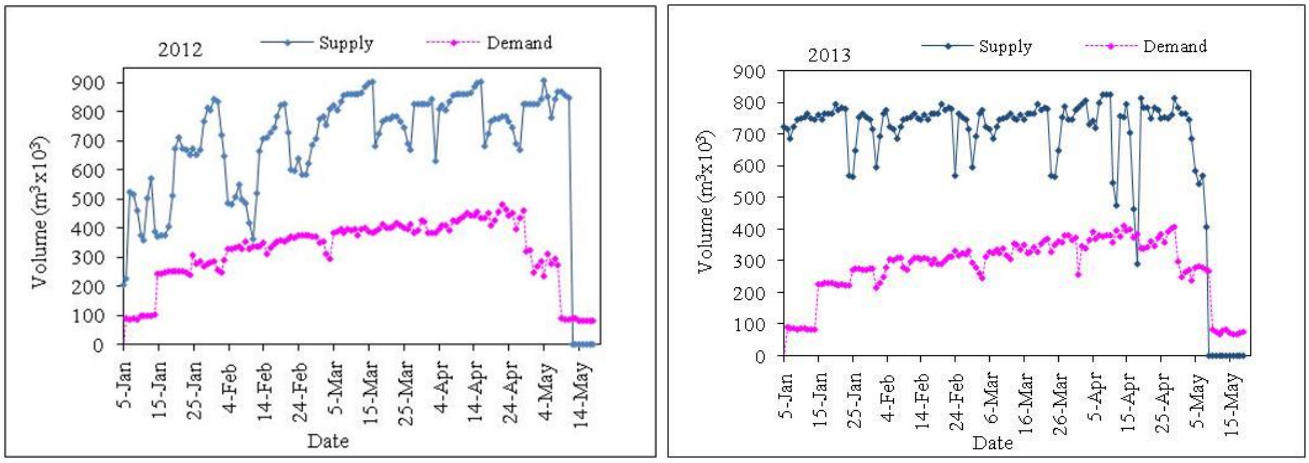

Fig 1: Daily water supply and demand pattern of served area for 2012 and 2013

Conclusions

The canal supply and daily demands at the system source for served area during study year 2012 and 2013 were compared. It was observed that for served area, the supply was more than the demand in most of the days. Only for a few days, the supply was less than the demand. The seasonal applied depth of water, for served area, was 228.59 and 259.75 cm in the years 2012 and 2013, respectively which was 112.52% (2012) and 138.25% (2013) more than the demand (107.60cm in 2012 and 109.02cm in 2013). Therefore, with the surplus/excess water more area can be brought under summer rice cultivation or in other ways irrigation water can be

utilized for some other prescribed purposes for downstream.

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