STUDY OF CROP WATER REQUIREMENT OF DIFFERENT CROPS IN HIRAKUD COMMAND AREA

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Abstract: A scientific management culture should enter the field of our irrigation system operational management: only then the irrigation system set up with enormous investments through the various five-year plans can be sustained to ensure reasonable returns. In India, the introduction of systems based on information technology for monitoring and controlling canal operations is necessary to improve water management not only at the operational level but also at the farm level. As the farmers are the end- users, when new technology is applied, they have to be informed during implementation of the improvements planned and of the anticipated benefits which they may gain .It is the fact that Odisha is a predominantly agrarian state as more than 2/3rd of the state population depends on agriculture. Hirakud dam over Mahanadi River in Odisha, India is one of such scheme which was early days of Independence having live storage capacity of 5,375 cum. It provides Irrigation potential of 1, 59,106 Ha during Kharif and 1, 08,385 Ha during the Rabi season through a system of canals. The present crop pattern is mainly based on Rice and very small amount of cultivation of other crops are going on. The phenomenon of crop rotation is not practiced in these parts and hence the quality of soil is degrading day by day, also the farmers are applying more fertilizers and irrigation water for the cultivation process. New techniques such CROPWAT 8.0, have been used in this study to predict the volume of water needed for the most effective irrigation and to increase the irrigation efficiency of the existing system. This will bring benefit to the farmers of the locality.

Keywords: canal operations, irrigation potential, irrigation efficiency.

1. Introduction

Water is the greatest resource of humanity. It not only helps in survival but also helps in making life comfortable and luxurious. Besides various other uses of water, the largest use of water in the world is made for irrigating lands. Irrigation in defined as "a continuous and a reliable water supply to the different crops is accordance with their different needs". When sufficient and timely water does not become available to the crops, the crops fade away, resulting in lesser crop yield, consequently creating famines and disasters. Irr6igation can thus save us from such disasters. The specific objectives of the paper are as follows:
I- To assesses and monitors the irrigation efficiency **II-**To study the various crop patterns.

It can, therefore be concluded that if full irrigation facilities are not developed, and modernization is not done in irrigation practices, the production of crops will be reduced, as the yield of various crops will reduce. And if sufficient food grains are not available it will lead to famines and economical destruction of the country. Various studies have been conducted as follows. Frizzone et al. (1997) developed a separable linear programming model, considering a set of technical factors which may influence the profit of an irrigation project. Royce et. al (2001) studied a model based optimization of crop management for climate forecasting applications, the conventional use of crop models limits on experiment to a small predetermined subset of the possible combinations of variables. They considered nine management variables for optimizations, at two levels of resolution (increments or step size) for each variable. They achieved reliability and efficiency by using optimization algorithm, Adaptive Simulated Annealing (ASA). They did not find the precise optimal solution but they found the optimal region with small difference in some management variables. The model presented an objective function that maximized the net income and specified the range of water availability. Reddy and Kumar (2007) have evaluated the strategies for crop planning and operation of irrigation reservoir system using multi-objective differential evolution. They proposed multi-objective differential evolution (MODE) approach for the simultaneous evolution of crop planning and operation of irrigation reservoir system and evolution of

optimal cropping pattern and operation policies for a multi-crop irrigation reservoir system. Under varying hydrological conditions, the fixed cropping pattern with conventional operating rule curve policies, a nonlinear multi-objectives optimization model was formulated. MODE model evaluated different strategies for irrigation planning and reservoir operation policies and select the best possible solution appropriate to the forecasted hydrologic condition. Baniket.al (2014) derived about a comparative crop water assessment using CROPWAT. They investigated the potential of CROPWAT to model the water assessment of using field data. They had considered maximum temperature, minimum temperature, relative humidity, sun shine hour, wind speed, soil data and rain fall data. The result obtained by CROPWAT model was compared between plain and hilly region for rice and wheat crop to meet irrigation demand of crops.
Brown (2007) developed an optimal stochastic multi-crop irrigation scheduling algorithm, which was able to incorporate complex farm system models, and constraints on daily and seasonal water use, with the objective of maximizing farm profit.

2. Methodology

Performance assessment requires a frame work that enables a manager to effectively use the data collected as part of routine task of operating and maintaining irrigation systems. The purpose of any framework is to form link between repeated actions in such a way as to provide a learning experiences for the managers that allow things to be done better in each successive iteration. The two approaches that provide the basis for developing workable frameworks are the nested system framework and performance diagnosis framework. Monitoring is essential in providing the basic data used for performance assessment, but in its now form it is merely data. A true performance indicator includes both an actual value and a target value that enables its user to quickly assess the amounts of deviation and a standard that allows the manager to determine if the deviation is acceptable. It is therefore desirable where every possible to express the indicators in form of a ratio. It is important to ensure that the indicators selected for a system will describe performance in respect of the objectives established for the system. It is the process that links to use of indicators to the overall performance assessment framework.

2.1 CROPWAT

CROPWAT 8.0 for Windows is a computer programme for the calculation of crop water requirements and irrigation requirements from existing or new climatic and crop data. Furthermore, the program allows the development of irrigation schedules for different management conditions and the calculation of scheme water supply for varying crop patterns.

This Windows version is based on the DOS versions CROPWAT 5.7 of 1992 and CROPWAT 7.0 of 1999. Apart from a completely redesigned user interface, CROPWAT 8.0 for Windows includes a host of updated and new features. These include:

- Monthly, decade and daily input of climatic data for calculation of eto.
- Backward compatibility to allow use of data from CLIMWAT database
- Possibility to estimate climatic data in the absence of measured values
- Decade *and* daily calculation of crop water requirements based on updated calculation algorithms including adjustment of crop-coefficient values
- Calculation of crop water requirements and irrigation scheduling for dry crops and for paddy & upland rice
- Interactive user adjustable irrigation schedules
- Daily soil water balance output tables
- Easy saving and retrieval of sessions and of user defined irrigation schedules
- Graphical presentations of input data, crop water requirements and irrigation schedules
- Easy import/export of data and graphics through clipboard or ASCIIA text files
- Extensive printing routines, supporting all windows-based printers
- Context-sensitive help system

2.2.1 Water Requirement of Crops:

For proper growth and maturity of the crops, water is of vital importance throughout the crop period. If the natural rain is sufficient and timely so as to satisfy both these requirements no irrigation water is required for raising that crop. In England, for example, the natural rain falling regularly throughout the year satisfies both these requirements for practically all the crops, and, therefore irrigation is not significantly needed in England. But in a tropical country like India, the natural rainfall is either insufficient, or the water does not fall regularly, as required by the crop. Since the magnitude as well as the frequency of the rainfall varies throughout a tropical country, certain crop may require irrigation in certain part of the country, and the same crop may not require any irrigation in some other part of the country.

The term, Water requirements of a crop, means the total quantity and the way in which a crop requires water, from the time it is sown to the time it is harvested. It is very clear from above discussion that the water requirement, will vary with the crop as well as with the place.

Crop Period or Base Period:

The time period that elapses from the instant of its sowing to the instant of its harvesting is called the crop period. 2-The time between the first watering of a crop at the time of its sowing to its last watering before harvesting is called the Base period or the Base of the crop. 3-Crop period is slightly more than the base period, but for all practical purposes, they are taken as one and the same thing, and generally expressed in days. Hence, in future, the term like growth period, crop period, etc., will be used as synonym, each representing crop period, and will be presented by B (in days).

Delta of a crop:

Each crop requires certain amount of water per hectare for its maturity. If the total amount of water supplied to the crop (from the first to the last watering) is stored on the land without any loss, then there will be a thick layer of water standing on that land. This depth of water layer is known as Delta for the crop.

Duty of water:

The duty of water is defined as number of hectares that can be irrigated by constant supply of water at the rate of one cusec throughout the base period. It is expressed in hectares/cusec. It is denoted by D. The duty of water is not constant, but it varies with various factors like soil condition, method of ploughing, method of application of water, etc.

Factors Affecting the Water Requirement:

The following are the factors that affect the water requirement of crops.

1. **Water Table :**

   If the table is near to the ground surface, the water requirement will be less. If it is much below the ground surface, the water requirement will be more.

2. **Climate :**
   In hot climate, the evaporation loss is more and hence the water requirement will be more and vice versa.

3. **Ground slope :**
   If the slope of the ground is steep, the water flows down very quickly and the soil gets little time to absorb requisite moisture resulting in water loss. So, the water requirement will be more. But if the ground is flat, the water flows slowly and the soil gets sufficient time to absorb the requisite moisture. So, the water requirement is less.

4. **Intensity of irrigation :**

If the intensity of irrigation for particular crop is high, then more area comes under the irrigation system and the water requirement is more and vice versa.

5. Type of soil :

In sandy soil water percolates very quickly and cannot be retained. So, water requirement is more. But the clayey can retain water near the root zone of crop. So, it requires less water.

6. Method of Application of Water :

In surface method more water is required to meet up evaporation loss. In sub surface method less water is required as the soil just absorbs the optimum moisture. In sprinkler method also less water is required as it just moist the soil like rainwater.

2.2.2 Programme Structure

The CROPWAT programme is organized in 8 different modules, of which 5 are data input modules and 3 are calculation modules. These modules can be accessed through the CROPWAT main menu but more conveniently through the Modules bar that is permanently visible at the left hand side of the main window. This allows the user to easily combine different climatic, crop and soil data for calculation of crop water requirements, irrigation schedules and scheme supplies.

The data input modules of CROPWAT are:

1. Climate/ETo: for the input of measured ETo data orof climatic data that allow calculation of ETo Penman-Monteith;
2. Rain: for the input of rainfall data and calculation of effective rainfall;
3. Crop (dry crop or rice): for the input of crop data and planting date;
4. Soil: for the input of soil data for (only needed for irrigation scheduling);
5. Crop pattern: for the input of a cropping pattern for scheme supply calculations

The calculation modules of CROPWAT are:

I. CWR - for calculation of Crop Water Requirements
II. Schedules (dry crop or rice) - for the calculation of irrigation schedules
III. Scheme - for the calculation of scheme supply based on a specific cropping pattern

3. Study Area

The present study is carried on Command area of Hirakud canal system. This area is situatedat the western part of the Odisha. It was felt that the irrigation system of the area needs improvement. Every year water is released from the reservoir throughSason canal, Bargarh main canal and Sambalpur distributary on June for farmers to facilitate agricultural activities for the kharif crops.

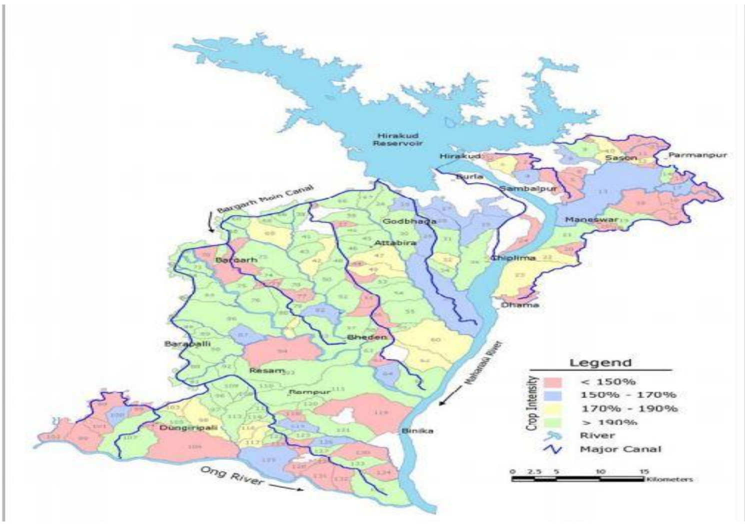

Fig.1 Hirakud Command Area

Hirakud Dam is multipurpose scheme intended for flood control, irrigation and power generation. The Dam is built across river Mahanadi at about 15 km upstream of Sambalpur town in state of Odisha. This is one of the oldest hydel projects of India, being the first post- independence major multipurpose river valley project in the country. The dam is located 6 kms from National highway 6. The nearest rail head is Hirakud railway station which is at a distance of 8 kms from the dam site.

4. Results & Discussions

Cropping activities go on all the year-round in India, provided water is available for crops. More than 70% of the Indian population is directly or indirectly connected with agriculture.

From the agricultural point of view, the year can be divided into two principal cropping seasons, i.e. Rabi and Kharif. Normally, Rabi starts from 1st October and ends on 31st March; while Kharif starts from 1st April and ends on 30th September. These dates are not rigid deadlines. The Kharif crops are rice, bajra, jowar, maize, cotton, tobacco, groundnut etc. The Rabi crops are wheat, barley, gram, linseed ,mustard, potatoes etc. Kharif crops are also called 'summer crops' and Rabi crops as 'winter crops'. Kharif crops are requiring about 2-3 times the quantity of water required by Rabi crops.

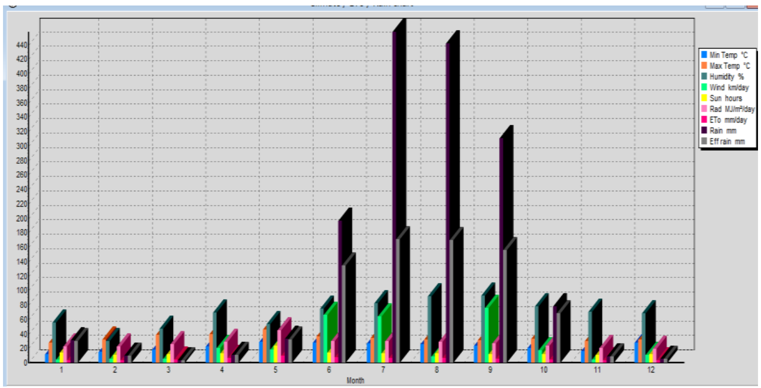

Fig.2 Graphical presentation of weather data from 2005 to 2016

Schedule:

Proper scheduling is the first step in producing high quality blooming poinsettias that reach the desired height and flowering dates. Using the forms provided, each product should be 'scheduled' as part of the planning process before cuttings are ordered and arrive at the greenhouse. The crop schedule of the paddy as calculated from crop wat is given below

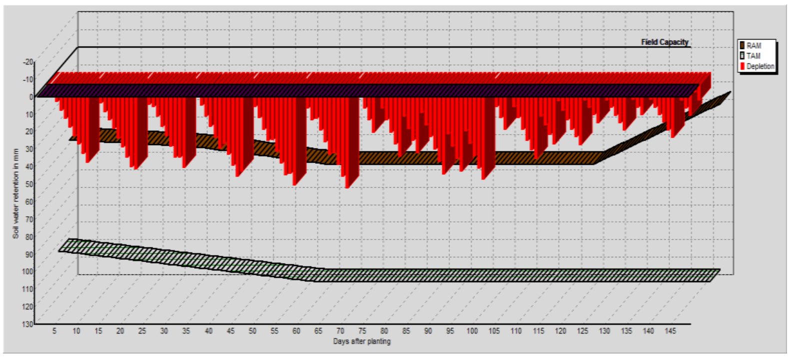

Fig. 3 Representation Schedule of Rice (Paddy)

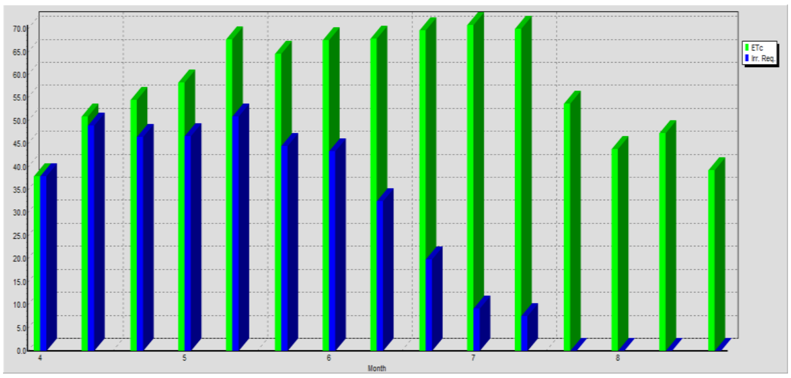

Fig. 4 Representation CWR of Rice (Paddy)

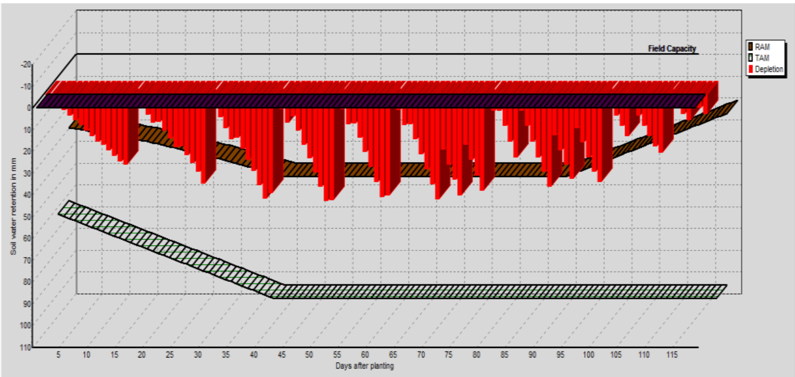

Fig. 5 Representation Schedule of Mung

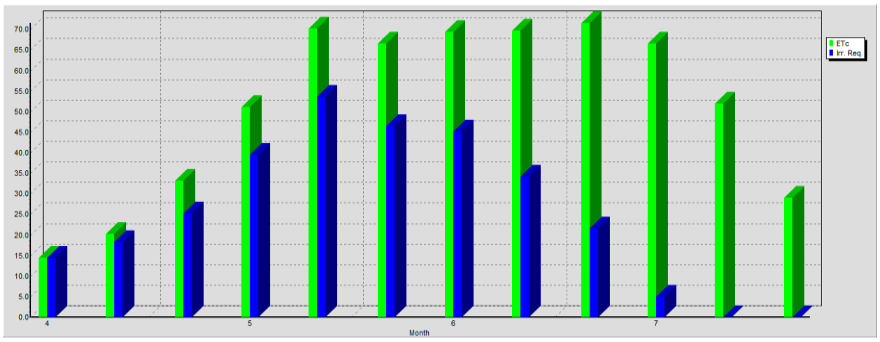

Fig. 6 Representation CWR of Mung

Table1 Representation of Area, Notation & Crop Water Requirementof crops

CROP NAME	NOTATION OF CROP	AREA OF CROP	CWR(cm)
Paddy	P	1460000000	`50.49
Maize	M	330000000	40.73
Jowar	J	80000	33.4
Ragi	R	150000	33.4
Arhar	A	120000000	39.7
Mung	MU	400000000	39.7
Biri	B	200000000	39.7
Kulthi	K	4130000	41.81
Pulses	PU	3980000	32.84
Ground nut	G	10000000	29.86
Til	TI	330000000	30.73
Caster	CA	200000	30.73
Mesta	ME	2400000	29.85
Swt. Potato	SP	100000000	41.11
Vegetables	V	4120000000	35
Chilli	CH	250000000	33.4
Ginger	G	1420000000	34.25
Turmeric	TU	20000000	34.25
Sugarcane	SC	4000000	78.05

1. Conclusion

Production in HIRAKUD Irrigation system has decreased due to losses of canal water, water logging, and seepage. Farmers of tail end are not receiving requires amount of water due to excess tapping at head reach of the canal. It is observed that the engineers of Irrigation department are not adopting the modern instruments for monitoring the flow in the canals, which leads to frequent blame of public. The use of modern scientific tools like CROPWAT can assess the water requirement of crops with large accuracy and suggest the crop pattern and crop rotation which can be readily acceptable to farmers. The study reveals that the benefit of the farmers can be enhanced in both Rabi and Kharif by adopting suitable cropping pattern.

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