Rainfed two levels, seasonal and intra-seasonal competition for

Business, Management

Rainfed regions in India account for 94 million ha, which is 65% of the net sown area. About 95% of coarse cereals, 86% of pulsesand 81% of oilseeds areas of the country are produced in rainfed areas. Parthasarathy Committee Report (2006) says, “ It is the rainfed parts of Indianagriculture that have been the weakest, they are also the ones that contain thegreatest unutilized potential for growth, and need to be developed if foodsecurity demands of 2020 are to be met.” The major constraint in increasingproduction from rainfed areas is to increase sources of irrigation. In easternIndia, the rainfed agriculture is over 67% of the net sown area.

The regionreceives mean annual rainfall of 1500 mm, which seems to be sufficient to growtwo crops in sequence provided the rainfall events are uniformly distributed inspace and time throughout the total cropping seasons, whereas it is associatedwith random phenomena. South-west monsoon in India is responsible for growingrainy/monsoon season (kharif) cropsand its onset, withdrawal, and intra-seasonal distribution are erratic innature. Rao etal. (1990) addressed the problemof water allocation of a limited water supply for irrigation of several cropsgrown in the same season using a dynamic framework by decomposition to twolevels, seasonal and intra-seasonal competition for water. Moreover, uneven distribution of monsoon rain in rainfed areas causes crop failure due toshortage of soil moisture in the root zone during its critical growth period. During monsoon season, the maximum rainfall received between June to September is nearly 1200 mm withsome high intensity of rainfall that contains nearly 60% of annual rainfall (Pisharoty, 1990). For such high intensityrainfall causes excess runoff and soil erosion from the crop field.

The on-farm reservoir (OFR) is a smallstorage structure constructed for collecting surface runoff from the field. Thedesign of the OFR consists of finding a suitable combination of surface area, depth of storage and a permissible side slope for a given storage volume. Agood number of works has been done on the performance evaluation of the OFR forirrigation purposes using different crops in different part of the country. Roy et al. (2009) developed user-friendlysoftware, using Visual Basic 6. 0 program to find out the optimal size of theOFR in terms of percentage of field area by simulating the water balance modelparameters of the crop field and the OFR. The user has to specify the crops tobe grown in the fields, irrigation management practices of the crops, types ofOFR (lined or unlined), side slope, depth of OFR, and field sizes.

Panigrahi et al.(2001) developed a dailysimulation model to determine the size of OFR that enables the farmers toprovide supplemental irrigation to rice. Irrigation for rice is provided duringthe critical growth stages only and the rest of the period is rainfed.

The major challenge in enhancing food grain production in eastern India comesfrom its rainfed uplands. The on-farm reservoir (OFR) designed for harvestingand recycling of rainwater for rice based cropping pattern in rainfed lowlands (Srivastava, 2001; Islam et al., 1998) and uplands(Panigrahi et al., 2007) appears to be afull proof technology for enhancing rice production during drought years. Butthe technology is not sound enough to guarantee optimum yield from wintercrops.

Because, a rice crop cultivated at the upstream of the reservoirobstructs a large amount of runoff to maintain its depth of ponding requirementand also requires equally enough water as supplemental irrigation during itscritical growth stage. This is the reason why the reservoir lacks adequatestorage for meeting the irrigation requirement of winter crops. In thiscontext, expecting an optimum yield of winter crops is seldom achieved. Out of 44 million ha of total rice area in thecountry, the upland rice occupies 7 million ha of which 75% is from easternIndia only (Kar et al.

, 2004). The averageyield of rice from this area is very low because of uneven distributionrainfall in crop growing season. Due to sandy loam type of soil in this area, it is impossible to maintain standing water in the crop field but for rice itis imperative to maintain even saturation condition throughout its growingseason. Alsothe scope of growing a second crop after withdrawal of monsoon is also verymuch limited due to quick depletion of soil moisture. The average yield ofcereals, oilseeds and pulses from the region are lagging behind the otherregions of the country (NAAS, 1998). On theother hand, rice dominant cropping practice resulted in lowering the croppingintensity in rainfed uplands but also contributed to bringing down theproductivity. Panigrahi and Panda (2003) developed a model forthe prediction of optimal size of an on-farm reservoir (OFR) so as to providesupplemental irrigation to rice in monsoon season and pre-sowing irrigation tomustard in winter for a rainfed farming system of eastern India. Mahendrarajah et al.

(1992) analyzed theoptimization of monsoonal water storage tank for supplemental irrigation underdouble rice cropping in Sri Lanka. The inter-seasonal irrigation allocation ofstorage was solved by deterministic dynamic programming using simulated cropresponse function. Panigrahi et al. (2005) documentedthat construction of the on-farm reservoir (OFR) is an alternative for thestorage of excess rainwater from the diked rice field during monsoon seasonfollowed by its reuse as supplemental irrigation to the rice in the same seasonand pre-sowing irrigation to mustard in the winter season. Mehta and Goto (1992) developed an irrigation pondmodel for the determination of minimum storage capacity at a desiredreliability level with a given intake, operating rule to meet the fluctuatingwater demands under various cropping patterns and hourly irrigation demands.

Forthis purpose, a soil water balance model is developed to determine the actualevapotranspiration, followed by formulating a dated production functionrelating evapotranspiration and crop yield, which is included in the objectivefunction of the dynamic programing model to obtain the optimal irrigationdecisions. Prasad etal. (2011) formulated a weeklyirrigation planning linear programming model for determining the optimalcropping pattern and reservoir water allocation for an existing storage basedirrigation system in India. Vedula and Mujumdar(1992) formulated a model to obtain a steady state optimal reservoiroperating policy for irrigation of multiple crops with stochastic inflows byfirst using dynamic programming (DP) to optimally allocate the available wateramong all crops within a given period, and then evaluated the systemperformance using stochastic dynamic programming

(SDP) to optimize the benefitsover a full year. Umamahesh and Sreenivasulu (1997)developed a two-phase stochastic dynamic programming model for optimaloperation of irrigation reservoirs under a multicrop environment. The proposedmodel integrates reservoir release decisions with water allocation decisions.

The water requirements of crops vary from period to period and are determinedfrom the soil moisture balance equation taking into consideration thecontribution of soil moisture and rainfall for the water requirements of thecrops. The main objective of the present study is to determine theoptimum size of the OFR using dynamic programming.