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Research Paper :

Efficient utilization of harvested water through indigenously fabricated gravity operated drip irrigation system

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ABSTRACT

Bastar plateau zone of Chattisgarh state, receives an annual rainfall of 1400 – 1600 mm. Even though, after receiving such an abundant quantity of rainfall, still mono cropping system exists in the region. Suitable irrigation system was to be designed for the tribal farmers with low farm holding capacity to manage and create irrigation facility at their own home stead garden or as locally known as *badi.* Topography of the region plays a vital role in creating hindrances for suitable harvesting and conservation of runoff. Due to undulating and uneven topography, gravity operated drip irrigation system was designed for irrigating small patch of *badi* using indigenous materials like level plastic pipe and used medical syringes. The technology proved to be a blessing for the tribal farmers with low farm holdings for increasing the production and cropping intensity by increasing the irrigated area. The indigenous drip irrigation system is designed for 300 sqm area and the traditional drip system was designed for 0.1 ha of holdings. The design was based on developing gravitational water head by creating an overhead tank of 400 ltrs with height of 2-3 ft for indigenous drip system and 500 l with height of 5-6 ft. The low cost indigenous type drip irrigation system using main line of 12 mm diameter flexible pipe and with 6 mm diameter flexible level pipe as the laterals. Used medical syringe needles were used for drippers or emitters. Two different types of needles of 18 and 22 nos were used to fabricate the system. Tomato was grown during *Rabi* season followed by cultivation of bottle guard during summer season, by irrigating daily with 400 l of water. Over the last two years, tomato and bottle guard were successfully grown in *Rabi* and summer season with mean yield of 32.9 tonnes/ha and 12.4 tonnes/ha and average benefit cost ratio as 11.91 and 5.01, respectively. Looking on to the success over the small patch of badi, gravity operated pressure compensating traditional drip irrigation system was designed for 0.1 and 0.2 ha of upland farming situation. The system is successfully operated at 15 farm families at Bhataguda and Turenar villages, Jagdalpur Block, Dist. – Bastar covering a total area of 1.5 ha. Different vegetables *viz.,* chilli, brinjal and tomato are grown under this irrigation system.

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Key words : Harvested water, Drip irrigation system, Conservation of run off

Soil and water are the precious natural resources and must be conserved as possible. Bastar, the tribal predominant district of Chhattisgarh state is famous for its natural vegetation and topography. The district consists of a major portion of tribal inhabitant who due to their ignorance were involved in primitive method of cultivation practices and were confined to only mono cropping system. Although the area receives normal rainfall of 1413.2 mm with an average annual rainfall of 1213.6 mm, most of the rainwater goes waste in the form of runoff. This runoff often attains erosive velocity due to highly undulating topography of the region. Soil loss always has a very devastating effect on the fertility of the field and in turn on the yield of the crop. Even though, after receiving such an abundant quantity of rainfall, still mono cropping system exists in the region. Conservation structures play a vital role in improving the soil condition and maintaining the fertility of the field on sustainable basis. Suitable irrigation system was to be designed for the tribal farmers with low farm holding capacity to manage and create irrigation facility at their own home stead garden or as locally known as *badi.* Topography of

the region plays a vital role in creating hindrances for suitable harvesting and conservation of runoff. The vegetable cultivation in the Bastar plateau is restricted in the *badies* (kitchen garderns) and near the nala and river banks due to unavailability of irrigation facility and topography of the cultivable lands. Frederick (1993) examines the experience of Organization for Economic Co-operation and Development (OECD) countries in influencing the behavior of water users, and draws lessons from attempts to manage demand by imposing water use regulations and employing economic incentives. Farmers adopt traditional methods of cultivation with little or no use of fertilizers and plant protection measures. Irrigation facilities are negligible which is about 3% of the cultivated area hence, mono-cropping "rice-fallow" is prevalent. In the Bastar region, small dug wells are used as source of water for daily needs round the year in several places. Even during the summer months they are good source of water. Rosegrant (1997) lays out a number of strategies for managing water in the future will need to involve both the careful exploitation of new sources of water and strong measures to stimulate more efficient use of water. Shallow dug wells and small tanks were excavated under various developmental activities for land and water resources reforms. Only construction of water harvesting structures will not fulfill the objective of increase in double cropped or irrigated cropped area. Proper fabrication of low cost, indigenous with high water efficiency irrigation system has to be designed for fruitful adoption of system for efficient utilization of harvested water and increasing irrigated cropped area. Drip irrigation technology is suitable for developing countries because of its low cost and simplicity of design and installation. It has started gaining popularity in some upland watersheds in the Southeast Asian countries of the Philippines, Vietnam and Indonesia for vegetable production under agroforestry systems (Reyes, 2007). Vegetable cultivation can be promoted in the *badies* of tribal farmers for improving their livelihood and socio economic status. One of the major issues in irrigation came up as lack of power source for pumps or initial cost in the establishment of high technology micro irrigation system. Due to these socio-economic barriers, tribals of Bastar region were still forced to stick to rainfed farming only, which puts an end to the possibilities of their nutritional and economical safety. Brown *et al.* (1995) attempted to show how technologies where linked to farmer control, *i.e.* the level of control that a farmer would have over the design and investment decisions and over water management.

The present study makes an attempt to design and fabricate low cost, indigenous, low power required with high water efficiency irrigation system for round the year cultivation of vegetables after rainfed paddy. Advanced micro irrigation system working under the same gravitational force principle was designed for irrigating 0.1 and 0.2 ha of fields.

METHODOLOGY

Under All India Coordinated Research Project for Dryland Agriculture, SGCARS, Jagdalpur many interventions were planned and executed for efficient recycling and reuse of harvested water which shall be practically feasible and adoptable by the tribal famers under rainfed farming situation. Looking on to the challenge, long term rainfall data collected at the Agro meteorological station, SGCARS, Kumhrawand, Jagdalpur were tabulated, studied and analyzed to determine the actual water availability for the region. Fig. 1 shows the long term rainfall pattern at Bastar region and its behavior over the past 30 years and Table 1 shows the normal and annual rainfall with coefficient of variation as 14.13% during 2010.

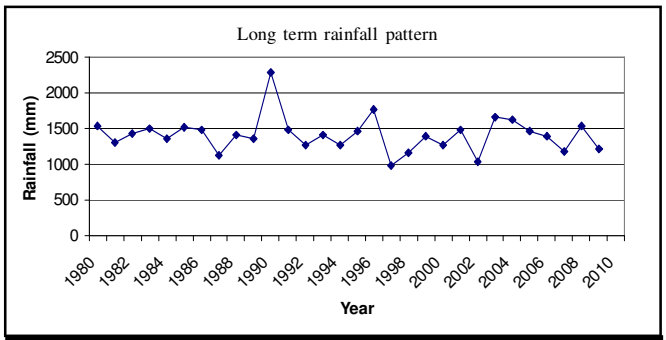

Fig. 1 : Changing rainfall pattern in Bastar

A drip irrigation system was developed by using two drums of 200 l capacity with fitted brass tap, main pipe: 12.5 mm diameter flexible plastic pipe, sub main pipe: 6.5 mm diameter flexible plastic pipe, other- dripper: Used medical syringes (18 nos and 22 nos syringe for maintaining uniformity coefficient); connectors: T-type plastics and plastic reducers. Used syringe needles of 18 and 22 nos (medical) formed the drippers of the system. All the materials are locally available in the open market. The size of the needles needs to be differed in order to maintain the water pressure till the end of the pipeline. Tomato was grown during *Rabi* season followed by cultivation of bottle guard during summer season. The water from the dug well was lifted manually to fill two drums (200 l capacity each) daily in the evening and irrigating for about half an hour. The irrigation was given

Table 1: The annual rainfall, seasonal rainfall, annual rainy days and seasonal rainy days of Bastar district of Chhattisgarh

Station name	Normal annual rain fall (mm)	Average annual rainfall (mm)	CV (%)	Seasonal rainfall (mm)	Annual rainy (days)	Seasonal rainy (days)
Bastar	1413.2	1213.6	14.13	1006	87	71

through the drips to each of the plants. Daily monitoring and observation was recorded for each of the plants.

Advanced micro irrigation system working under the same gravitational force principle was designed with one 500 l overhead tank fitted at a height of 5-6 ft for creating the required water head for the pressure compensating drip irrigation system to operate. The system was designed to run with low power consumption as the farmer has to fill the overhead tank once at every two days interval period. As the water availability in the shallow dug wells excavated (size 30 ft depth and 2 m dia) at the *badies* have low runoff harvesting capacity, so the system was designed to exploit only 500 l (0.5 cum) of water at a time for irrigation of vegetables grown in the *badi*. Also the power consumption is very less as compared to common practice of irrigating the field by pump, where the pumps continuously operate throughout the irrigating time. Tomato, brinjal, chilli etc vegetable crops are grown in the farmers field at village Bhataguda and Turenar, Block Jagdalpur, Dist.- Bastar. This technology will be replicated in associated blocks for increasing the irrigated area of the region and thereby improving the socio economic status of the tribal farmers.

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussion have been summarized under following heads:

Water availability:

The water availability in the shallow R.C.C. ring dug wells was observed to be limited as the geology of the upland of the region is having low water holding and recharging capacity. The shallow dug wells helps in recharging the ground water table of the upland during the rainy season. About 35 cum of rain water is retained in the open well and is available for reuse for irrigation. If judiciously used, the available water is quite enough for irrigation 0.1 – 0.2 ha of land under micro irrigation system. The open R.C.C. dugout shallow well is playing a key role in increasing the water resources at the door step of the tribal farmer and thereby encouraging and motivating them to grow vegetables in their *badies* for nutritional and economic security.

Drip irrigation:

The indigenous drip irrigation system was found to be working with 0.64 lph discharge capacity. 22 no needles (small size) were fitted in the upper portion of the field and 18 no needle (big size) were fitted on the lower portion of the field. This difference in the needle size was done to manage the water head at the lower portion of the field. The uniformity coefficient of the system was found to be 83% which can be considered good for such a low cost drip system. The experimental plot at the station was 300 sqm with 50 drip laterals at an interval of 60 cm and each lateral having 25 needles as drippers. For total 1250 plants of tomato, 400 l of water was found sufficient per day against 1500-1600 l per day water requirement through traditional irrigation system, thereby saving 73% of precious harvested water along with reduction in drudgery.

The advanced gravity operated pressure compensating drip irrigation system was successfully tested at the farmer's field for cultivation of tomato, brinjal,

Fig. 2 : Experimental layout of indigenous drip irrigation system with glimpses of harvesting of tomato and bottle guard grown

chilli, cauliflower etc. vegetables in small field of 0.1 – 0.2 ha. 500 l overhead tanks were established at height of 5 – 6 ft for proper water head and maintaining the uniformity coefficient to more than 85%.

The fallow left over field in absence of irrigation facility can be brought under cropped area and thus increase the cropping intensity.

Yield of vegetable and economic return:

On the basis of the experiment conducted on the Farm of SGCARS, Kumhrawand, Jagdalpur, significantly higher yield of 32945.5 kg/ha, with BC ratio of 11.91 was obtained from tomato crop under midland and lowland farming situations during *Rabi* season and bottle guard gave yield of 12417.85 kg/ha with BC ratio of 5.06 was obtained in summer season in the study during the period of 2008 – 2010.

Conclusion:

Proper management of harvested water though in small quantity can lead to better production and yield which will definitely help in improving the socio economic status of the tribals inhabitants along with providing nutritional security. The indigenous low cost methods with high efficiency should be designed and fabricated in large scales for better adoption among the small farmers. High initial cost of any implement, machine and technique can not prove its wide spread in the traditional community of small land holding farmers. So, emphasis should be imparted on providing small and efficient techniques to small and marginal farmers of the region for increasing the cropping intensity and contributing to the growth of state and in turn the growth of the nation.

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