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A Case Study

Irrigation water conservation in *Teesta* flood plain of North Bengal, India: A holistic approach

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Teesta flood plains of West Bengal located at *Sub-Himalayan* part of *Terai* agro-climatic zone of West Bengal experiences typical pre-humid climate with high annual rainfall (more than 3000 mm), high relative humidity (average maximum and minimum of 95 and 65 %, respectively) and moderate temperature (average maximum and minimum of 31^0C and 11^0C, respectively). Critical observation on distribution pattern of rainfall revealed that the pattern is erratic as evidenced by the fact that out of total annual rainfall more than 75 per cent (2200 - 2500 mm) is received during June to September and out of rest amount 75 - 80 per cent is received as pre-monsoon rainfall during April and May, keeping the entire *Rabi* season almost dry. Such an unequal distribution of rainfall leaves no other option for vegetable growers of this region but to depend on ground water lifted by diesel operated pump using bore well as source. Reliance on irrigation water is further increased due to low water holding capacity of soils. Keeping all these in mind demonstration programmes on water saving irrigation method *viz.*, broad bed and furrow (BBF) method of irrigation and *in-situ* moisture conservation technology *viz.*, organic mulching were carried out at farmers' field to minimise use of irrigation water for vegetable cultivation, to reduce the irrigation cost, environmental pollution and to save the ground water.

Initiatives of Cooch Behar KVK :

Demonstrations were carried out by Cooch Behar KVK at village Khagribari of Cooch Behar district, West Bengal (latitude 26°26.4´ N, longitude 89°21.5´ E) under the project National Initiatives on Climate Resilient Agriculture (NICRA) during the year 2011-12 and 2012-13.

Technology 1 : BBF method of irrigation in brinjal and cucumber :

Broad bed of 95 cm wide and 12-15 cm height were made with 30 cm wide irrigation channel in between two bed and seedlings of brinjal were planted during September in two rows with 90 cm spacing in between rows; where as in case of cucumber 150 cm wide and 12 - 15 cm height bed were made with 30 cm wide irrigation channel in between two beds and seeds of cucumber were directly planted in the bed during October having two rows in each bed at 115 cm apart. All other management practices remained same in both BBF and farmers' practice of ridge and furrow (RF) method for both brinjal and cucumber (Fig. 1).

Benefits of BBF method of irrigation in brinjal and cucumber :

Savings of irrigation water :

Data presented in Table 1 showed that though the total number of irrigation during crop life as recorded were 12 in case of brinjal for

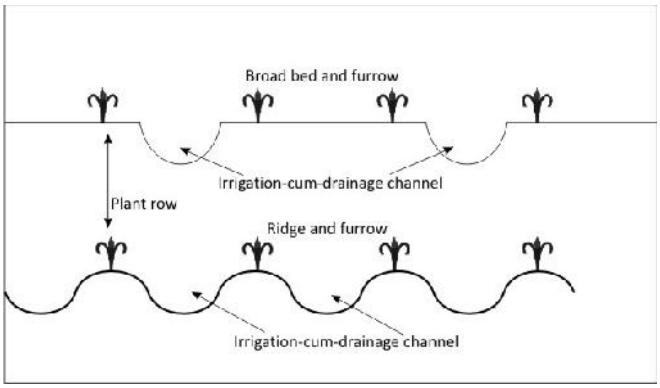

Fig. 1: Method of irrigation

both BBF and RF method of irrigation but the average duration per irrigation per hectare was 3 hours 45 minutes less in BBF method as compared to RF method resulting average total reduction of 45 hours of irrigation period per hectare. Irrigation water requirement of brinjal as calculated was 30.24 ha-cm in BBF method against 43.20 ha-cm in RF method with total savings of 12.96 ha-cm irrigation water (30 % over RF method). A reduction in irrigation cost to the tune of Rs. 2700.00 per hectare was observed in BBF method of irrigation. On the other hand in case of cucumber total number of irrigation applied during crop life remained same (9 number) for both BBF and RF method of irrigation and it was less than that of brinjal but average duration per irrigation per hectare was less than that of brinjal which was probably due to the fact that planting of cucumber was done during October when the zone started to experience dry spell (Fig. 2 and 3). Here also average duration per irrigation per hectare was 4 hours 22 minutes less in BBF method over traditional RF method and average reduction in duration of total irrigation per hectare during the crop tenure was 39.37 hours. Irrigation water requirement of cucumber was 24.30 ha-cm ha^{-1} and 35.64 ha-cm ha^{-1} in BBF and RF method, respectively and thus, there was saving of 11.34 ha-cm ha^{-1} irrigation water which was 31.82 per cent of irrigation water requirement in RF method. Cost of irrigation was also reduced to the tune of Rs. 2632.00 per hectare in BBF. For both crops reduction in total duration of irrigation hour in BBF method can be explained by the fact that in BBF method surface area of irrigation-cum-drainage channel was much lower than traditional RF method.

Fig. 2 : Broad bed and furrow (BBF) method of irrigation in brinjal

Fig. 3 : Broad bed and furrow (BBF) method of irrigation in cucumber

Increase in WUE :

Yield of brinjal and cucumber presented in Table 2 hardly showed any variation between BBF and RF method, as a result of which WUE of brinjal increased from 590.74 kg / ha-cm in RF method to 842.92 kg / ha-cm in BBF method reflecting 42.68 per cent increase; where as in case of cucumber the magnitude of WUE in BBF method was 1293.00 kg / ha-cm which was 409.17 kg / ha-cm (46.30 %)

Table 1: Effect of BBF method on irrigation

Technology option	No. of irrigation	Duration (min)/ irrigation / ha	Total duration (hr)/ha	IWR(ha-cm) / ha	Irrigation cost (Rs. / ha)
Crop : Brinjal					
RF method	12	750	150.00	43.20	9000.00
BBF method	12	525	105.00	30.24	6300.00
Crop : Cucumber					
RF method	09	825	123.75	35.64	7425.00
BBF method	09	563	84.38	24.30	5063.00

higher than RF (883.83 kg/ha-cm) method of irrigation (Table 2).

Reduction in air pollution :

Average diesel consumption by 5 HP diesel operated pump was one litre per hour. The magnitude of reduction in total irrigation period per hectare in BBF method over RF method was 45 hours and 39.37 hours in case of brinjal and cucumber, respectively. So, consumption of diesel was reduced to the tune of 45 litre and 39.37 litre in BBF method over RF method of irrigation for irrigating one hectare of brinjal and cucumber, respectively. Furthermore, every litre of diesel consumed by the irrigation pump, 2.60 kg carbon dioxide is released to the atmosphere. So, BBF method of irrigation prevented emission of 117 kg and 102.33 kg of carbon dioxide to the atmosphere compared to RF method for irrigating one hectare of brinjal and cucumber, respectively (Table 2).

Technology 2 : Use of rice straw as mulch material in tomato :

Seedlings of tomato were planted on 12 - 15 cm raised and 70 cm wide bed during middle of September accommodating two rows in each bed. Rice straw was spread over the bed as mulch material immediately after planting of tomato seedlings. Other management practices were similar to that followed by farmers of the village.

Data on yield of crop, number of irrigation applied during crop life, duration of each irrigation, fuel consumption per hour and irrigation costs were recorded. Water that is discharged in 5 seconds (recorded by stop watch) by a 5 HP diesel pump was measured by measuring cylinder after collecting in a 50 litre drum for calculating the discharge rate and the average discharge rate of 5 HP diesel pump at the operational village was calculated as 8 litre per second. Total duration of irrigation during crop life and irrigation water requirement (IWR) was calculated using the collected data.

Benefits of use of rice straw as mulch material in tomato:

Savings of irrigation water :

Results presented in Table 3 showed that total 9 numbers of irrigation required for tomato when rice straw was used as mulch material as compared to 13 numbers of irrigation when no mulch material was used (Fig. 4). Duration of per irrigation per hectare remained same in both crop grown on mulch and without mulch. Lesser evaporation loss

Fig. 4 : Mulching with rice straw in tomato

Table 2 : Effect of BBF method on yield, WUE and fuel consumption

Technology option	Yield (t / ha)	WUE (kg / ha-cm)	Diesel consumption (litre / ha)	Carbon dioxide emission (kg / ha)
Crop : Brinjal				
RF method	25.52	590.74	150.00	390.00
BBF method	25.49	842.92	105.00	273.00
Crop : Cucumber				
RF method	31.50	883.83	123.75	321.75
BBF method	31.42	1293.00	84.38	219.39

Table 3: Effect of organic mulching on irrigation

Technology option	No. of irrigation	Duration (min)/Irrigation / ha	Total duration (hr)/ha	IWR (ha-cm)/ha	Irrigation cost (Rs. / ha)
Crop : Tomato					
Without mulch	13	825	178.75	51.48	10,725
With mulch	09	825	123.75	35.64	7,425

Table 4: Effect of organic mulching on yield, WUE and fuel consumption

Technology option	Yield (t / ha)	WUE (kg / ha-cm)	Diesel consumption (litre / ha)	Carbon dioxide emission (kg / ha)
Crop : Tomato				
RF method	26.92	522.92	178.75	464.75
BBF method	27.10	760.38	123.75	321.75

of moisture from soil under straw mulching increased interval between two successive irrigations by 4-5 days in tomato under straw mulching. So, mulching with rice straw caused reduction in total duration of irrigation by 55 hour ha^{-1} over traditional practice of tomato cultivation without any mulching material. Reduction in total irrigation hour per hectare resulted in curtailment of irrigation water requirement by the crop to the tune of 15.84 ha-cm (30.77 %) in demonstration plots over farmers' practice of no use of mulch. Cost of irrigation was also reduced from Rs. 10,725.00 ha^{-1} in normal cultivation to Rs. 7,425.00 ha^{-1} in demonstration plots. Moreover use of straw mulch may increase the organic matter content of soil in long term resulting better soil health and increased water holding capacity which could further increase the efficiency of irrigation water to be applied.

Increase in WUE :

There was not much difference in average yield of tomato under plots with organic mulch and no mulch (Table 4). Irrigation water requirement was much higher in plots where no mulching material was used, resulting increase in WUE of tomato by 45.40 per cent from 522.92 kg ha-cm^{-1} in farmers' practice to 760.38 kg ha-cm^{-1} with rice straw mulch (Table 4).

Reduction in air pollution :

Total amount of diesel required for irrigating one hectare of tomato by 5 HP pump was 178.75 and 123.75 litre with and without mulching, respectively saving 55 litre of diesel which could prevent emission of 143 kg carbon dioxide (Table 4) to the atmosphere compared to farmers' practice of cultivating tomato without any mulching.

Summary :

Water saving irrigation method like BBF method in brinjal and cucumber as well as *in-situ* moisture conservation technology like organic mulching in tomato proved to be efficient not only in reducing the IWR, irrigation cost and increasing the WUE without altering yield of crops; but also in checking air and sound pollution.

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