Increasing Rainfed Pigeonpea and Groundnut Water Productivity through Supplemental Irrigation from Farm Pond in Micro-Watershed of Raichur

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ABSTRACT: Rainwater management is the most critical component of rainfed farming. Successful production of rainfed crops largely depends on how efficiently soil moisture is conserved *in-situ* or the surplus runoff is harvested in farm ponds, stored and recycled for supplemental irrigation. A field experiment was conducted to find out the catchment-storage-command relationship for enhancing water productivity in micro-catchment of University of Agricultural Sciences (UAS) campus, Raichur. A square shaped (trapezoidal section) farm pond of size 18 x 18 m top width, 10x10 m bottom width and 2.70 m depth was excavated. The total capacity of the pond was 547.0 m^3. The catchment and command area were delineated as 8 and 1 ha respectively. In 2019, there were six runoff events. The highest sediment yield during the season was calculated by collecting the runoff samples from the runoff events, and it was 0.40 t/ha against the rainfall of 113.00 mm and runoff volume of 2985.50 m^3. In 2020, the highest sediment yield recorded was 0.358 t/ha against the rainfall of 83.60 mm and runoff of 33.84 mm with runoff volume of 1596.40 m^3. Supplemental irrigation (SI) was provided in first year to pigeonpea crop during pod filling stage and higher yield of 12.27 q/ha was recorded as compared to without supplement irrigation (11.20 q/ha). Higher rain water use efficiency (RWUE) of 1.85 kg/ha-mm was obtained under supplemental irrigated as compared to without supplement irrigation (1.76 kg/ha-mm). Higher net returns of Rs. 39120 and benefit cost ratio of 2.13 was recorded in SI field as compared to without SI. During second year, the SI for groundnut was provided during pod development stage and higher yield was recorded (15.26 q/ha) as compared to without SI (13.15 q/ha). Higher RWUE of 2.75 kg/ha-mm was recorded under SI as compared to without SI (2.57 kg/ha-mm). Higher net returns of Rs. 41378 and benefit cost ratio of 2.05 was recorded with SI as compared to without SI. In semi-arid regions of Karnataka, runoff water harvesting in a pond and using the collected water through SI could be a promising option for enhancing the productivity of pigeonpea and groundnut.

Key words: Micro catchment, storage, command, farm pond, runoff, supplemental irrigation, yield, rain water use efficiency, sediment yield

Introduction

Rainfall is a basic resource for all the forms of water in semi arid tropics of India. Rainwater management is the most critical component of rainfed farming. Several management options are available at the farm scale to increase rainwater use efficiency. Some of these are management of crop residues to improve infiltration and reduce sediment levels, construction of farm ponds for collection of excess rainfall flowing from the farm area, crop rotations and soil amendments (Freebairn *et al.,* 1986). The successful production of rainfed crops largely depends on how efficiently soil moisture is conserved *in-situ* or the surplus runoff is harvested in farm ponds, stored and recycled for supplemental irrigation (Rao *et al.*, 2009). Several researchers have shown that on-farm runoff collection into dugout farm ponds and supplemental irrigation can increase and stabilize the crop production (Krishna *et al.,* 1987). There is an abundant scope and opportunity for harvesting excess runoff in the rainfed region in different states of the country (Wani *et al.,* 2003). Heavy rainfall followed by prolonged dry spell affects the crop yield in red sandy loam soils in the semi-arid areas of North-Eastern dry zone of Karnataka which have a constraint of low moisture holding capacity. Hence there is need to conserve moisture and harvest excess runoff during the rain events and manage the rain water to reduce the impact of moisture stress and bring about sustainability in agriculture production through farm pond technology, which is a promising technology for enhancing productivity. Farm pond could be used for supplemental irrigation when the crop is suffering from water stress due to dry spells during the season (Reddy *et al.,* 2012). Supplemental irrigation could be applied to the field through furrow (conventional) irrigation or through

Table 1: Runoff and sediment yield details for the year 2019

Sl. No.	Date of event	Rainfall (mm)	Runoff (m^3)	Runoff (mm)	Runoff per cent	Sediment yield (t/ha)
1	18/07/2019	35.00	142.50	2.378	6.80	0.03
2	18/09/2019	48.00	431.30	7.180	14.95	0.04
3	19/09/2019	42.00	944.20	15.737	37.50	0.20
4	25/09/2019	113.00	2985.50	49.578	44.03	0.40
5	04/10/2019	46.00	1086.70	18.110	39.20	0.12
6	25/10/2019	22.00	665.70	11.094	50.42	0.06

micro-irrigation (sprinkler/drip) technique (Nangia and Oweis, 2016). Supplemental irrigation increases not only yield but also improves water productivity when supplemental irrigation and rainwater are used conjunctively (Oweis *et al.,* 2000). A study was conducted with the objective of increasing rainfed pigeonpea and groundnut yield and water productivity through supplemental irrigation (SI) in semi-arid region of Karnataka.

Materials and Methods

Study area

The field experiment was conducted in micro-watershed of UAS Raichur campus, Raichur district, which comes under semi-arid region of Karnataka. A square shaped (trapezoidal section) farm pond of size 18 x 18 m top width 10 x 10 m bottom width and 2.70 m depth was excavated in the year 2017 in the dry land research plot at UAS, Raichur campus. The total capacity of the pond was 547 m^3. The catchment and command area were delineated as 8 and 1 ha respectively. The sub soil at the pond site was sandy loam with high seepage losses; hence the farm pond was lined with RCC concrete to prevent seepage losses. Supplemental irrigation was given during pod filling stage for both the crops i.e. pigeonpea and groundnut in an area of 0.485 ha each. The pigeonpea variety sown was TS-3R, which is a popular variety in North-Eastern dry zone, with a spacing of 90 cm row to row and 30 cm plant to plant. The groundnut variety sown was KDG 128, which is popular variety in this region, with spacing of 30 cm row to row, 10 cm plant to plant.

The runoff and sediment yield generated during individual runoff events were monitored using digital runoff recorder installed adjacent to the rectangular weir at the inlet section of the farm pond.

Results and Discussion

During the year 2019, there were six runoff events. The rainfall and runoff data and sediment loss data are presented in **Table 1.** The sediment yield was calculated by collecting the runoff samples from the runoff events. The highest amount of sediment was recorded on 25-09-2019 which is 0.40 t/ha against the rainfall of 113.00 mm and runoff volume of 2985.50 m^3.

Supplemental irrigation (SI) of 30 mm was provided to pigeonpea during pod filling stage through flood irrigation using diesel pump. Higher yield of 12.27 q/ha was obtained in SI **(Table 2)** plot as compared to without SI plot (11.20 q/ha). Higher rain water use efficiency (RWUE) of 1.85 kg/ha-mm was obtained under SI field as compared to without SI field with 1.76 kg/ha-mm **(Table 5)**. The total cost of cultivation incurred for growing pigeonpea was Rs. 34500 per hectare and gross return obtained was Rs. 73620 per hectare under SI field. Higher net returns of Rs. 39120 and benefit cost ratio of 2.13 was recorded with SI **(Table 5)** as compared to without SI.

During the year 2020, 61 rainy days were recorded, of which, 8 were high runoff causing rainfall events. Most of the runoff events occurred during the months of May, June, July, August, September, and October. The rainfall and runoff data and sediment loss data for 2020 are presented in **Table 3.** The highest sediment yield of 0.358 t/ha was recorded on 19-09-2020 against the rainfall of 83.60 mm and runoff of 33.84 mm with runoff volume of 1596.40 m^3.

Table 2: Details of supplementary irrigation provided to pigeonpea crop using pond water during 2019

Crop	Area (ha)	No. of Irrigations	Method of irrigation	Stage of irrigation	Yield (q/ha)
Pigeonpea with SI	0.485	1	Flood irrigation	Pod filling stage	12.27
Pigeonpea without SI	0.485	-	-	-	11.20

Table 3: Runoff and sediment yield details for the year 2020

Sl. No.	Date of event	Rainfall (mm)	Runoff (m^3)	Runoff (mm)	Runoff per cent	Sediment yield (t/ha)
1	30/05/2020	89.60	210.40	4.50	5.02	0.023
2	03/06/2020	25.00	58.70	1.25	5.00	0.010
3	16/07/2020	63.80	1149.80	24.38	38.20	0.335
4	21/08/2020	39.20	992.07	21.03	53.65	0.250
5	19/09/2020	83.60	1596.40	33.84	40.48	0.358
6	27/09/2020	66.40	1156.00	24.50	36.89	0.290
7	12/10/2020	45.00	905.70	19.20	42.66	0.220
8	14/10/2020	34.80	282.20	5.98	17.18	0.030

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Table 4: Details of supplementary irrigation provided to groundnut crop using pond water during 2020

Crop	Area (ha)	No. of Irrigations	Method of irrigation	Stage of irrigation	Yield (q/ha)
Groundnut with SI	0.485	1	Flood irrigation	Pod development stage	15.26
Groundnut without SI	0.485	-	-	-	13.15

Table 5: Yield, RWUE and economics of pigeonpea and groundnut with and without supplementary irrigation

Item	2019		Item	2020	
	Pigeopea			Groundnut	
	Without SI	With SI		Without SI	With SI
Grain yield (kg/ha)	1120.0	1227.0	Grain yield (kg/ha)	1315.0	1526.0
Rainfall (mm) + Supplement irrigation (30 mm)	635.2	665.2	Rainfall (mm) + Supplement irrigation (43.1 mm)	511.6	554.7
RWUE (kg/ha-mm)	1.76	1.85	RWUE (kg/ha-mm)	2.57	2.75
Cost of cultivation (Rs./ha)	34000	34500	Cost of cultivation (Rs./ha)	39000	39500
Gross returns (Rs./ha) @ Rs. 6000 /q	67200	73620	Gross returns (Rs./ha) @ Rs. 5300 /q	69695	80878
Net returns (Rs./ha)	33200	39120	Net returns (Rs./ha)	30695	41378
B:C ratio	1.97	2.13	B:C ratio	1.78	2.05

SI- Supplement irrigation, RWUE- Rain water use efficiency

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Supplemental irrigation of 43.1 mm was given to groundnut at pod development stage. Higher ground nut yield of 15.26 q/ha was obtained in SI field as compared to without SI field 13.15 q/ha **(Table 4)**. Higher rain water use efficiency (RWUE) of 2.75 kg/ha-mm was obtained under SI field **(Table 5)**. The total cost of cultivation incurred for growing groundnut was Rs. 39500 per hectare and gross income obtained was Rs. 80878 per ha. Higher net returns of Rs. 41378 and benefit cost ration of 2.05 was recorded in SI crop field **(Table 6)**.

Conclusion

This study shows the scope of supplemental irrigation for enhancing yield by mitigating moisture stress during critical stages of pigeonpea and groundnut. Supplemental irrigation from the farm pond water harvested through rainwater runoff increased the yield of pigeonpea, rainwater use efficiency, net returns and benefit cost ratio in 2019. In 2020, groundnut yield, rainwater use efficiency, net returns and benefit cost ratio were higher with supplemental irrigation. These results suggest that in semi-arid regions of Karnataka, runoff water harvesting in farm pond and using the collected water through supplemental irrigation could be a promising option for enhancing the productivity of pigeonpea and groundnut.

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