Int.J.Curr.Microbiol.App.Sci (2021) *10*(09): 375-383

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 10 Number 09 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1009.043

Studies on Rainwater Harvesting and Reutilization for Protective Irrigation with Farm Pond

M. More Ram[1*], D. Jagtap Raghunath[1], R. More Madhukar[1] and D. Harkal Anil[2]

[1]Department of Soil and Water Conservation Engineering, [2]Department of Farm Machinery and power, College of Agricultural Engineering & Technology, VNMKV, Parbhani-431602, M.S., India

**Corresponding author*

Keywords

Rainwater, harvesting, protective, irrigation, farm pond

Article Info

Accepted:
15 August 2021
Available Online:
10 September 2021

A B S T R A C T

The research on, 'Studies on rainwater harvesting and reutilization for protective irrigation with farm pond' was conducted during the year 2016-17 at demonstration farm of the Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The daily depth of water impounded in the farm pond was recorded for developing stage-storage relationship of the farm pond. For estimation of the loss of water through evaporation from farm pond, daily pan evaporation data was multiplied by pan co-efficient (0.70). The harvested water in the farm pond was utilized for applying protective irrigation to the pigeon pea crop. The experiment consisted six replications and two treatments. One protective irrigation for pigeon pea at pod development stage (T_1) was applied on 30.11.2016. The treatment T_2 consisted without protective irrigation to pigeon pea. The grain yield of pigeon pea was recorded plot wise.The grain yield data was analyzed using MAUSTAT software and results obtained were compared treatment wise. For economic analysis of the treatments, cost of cultivation, cost of cultural operations, fixed and operational costs of pump and accessories were calculated. These total cost was be used to determine the gross monetary returns (GMR), net monetary returns (NMR) and benefit cost ratio (B:C ratio). The area of top section and bottom section of the farm pond was 279.75 m^2 and 516.82 m^2 respectively. The average elevation of embankment at top was 413.130m. The average elevation of bottom of pond was 410.210m. The elevation at the bottom of outlet was 412.437m. The maximum depth of water impounded and maximum storage volume in the farm pond was 2.165m and 933.99m^3 respectively. The total water evaporated through farm pond for the month of July, August, September, October, November and December 2016 was found to be 19.14 m^3, 32.60m^3, 25.40 m^3, 35.9882m^3, 29.8620m^3 and 1.1965 m^3 respectively. The maximum water evaporated through the farm pond was recorded in the month of October-2016. Total evaporation loss through the farm pond recorded was144.17 m^3.The seepage loss through the pond for the month of July August, September, October, November and December 2016 was found to 634.88, 358.05 m3, 651.80 m^3, 611.64 m^3, 147.33 m^3, and 37.89 m^3 respectively. The maximum water seepage through the farm pond was recorded in the month of September -2016.The total seepage loss recorded through the farm pond was 2441.59 m3. The harvested water in the farm pond was utilized for irrigating the pigeon pea crop at its pod development stage. One of protective irrigation (T_1) recorded significantly higher pigeon pea grain yield than treatment of without protective irrigation (T_2). Due to the one protective irrigation, 27.30 per cent grain yield increased over or control was observed. The study revealed that the treatment T_1 *i. e*. one protective irrigations at pod development stage recorded highest GMR (111302.00Rs/ha) and NMR (76302.00) as compared to control (T_2) *i. e.* without protective irrigation. The benefit- cost ratio (2.18) is found to be higher under the treatment T_1*i. e*. one protective irrigation pod development stage. The lowest B:C ratio (1.69) is estimated under the treatment T_2 (without protective irrigation).

Introduction

In most parts of the Indian sub-continent, extraction of water from rivers and underground aquifers is causing severe environmental problems. In addition, runoff due to heavy rain can lead to accumulated flooding in high risk areas such as Eastern Utter Pradesh, Bihar, West Bengal and Assam. Despite this, due to the peculiar monsoonic climate in India, a large part of the year remains dry leading to drought or drought like situations in major parts of the country. The harnessing of excess rainfall from rooftops, catchments and protection of freshwater resources must therefore, be improved to ensure the required supplies of water for various purposes. It is therefore important that, adequate supplies of water be developed to sustain such life. Development of water supplies should, however, be undertaken in such a way as to preserve the hydrological balance and the biological functions of all ecosystems. At certain times during lean period or in rainy season when water is not needed for irrigation, it can be stored in secondary reservoir and used effectively during critical periods (Mann and Ramana Rao 1981). Crop failure is common event for want of pre-sowing irrigation, if rain is not received at sowing time of the crops (Srivastava, 1997).

Rainwater management is the most critical component of rainfed farming. The successful production of rainfed crops largely depends on how efficiently soil moisture is conserved in *situ* or the surplus runoff is harvested, stored and recycled for supplemental irrigation. India has a long history of rainwater harvesting through a variety of structures and systems built by the Government or local bodies and managed by the community or village level institutions. However, after independence, with the availability of electricity and pumping technology, private investment on tube wells has enormously increased and the tank systems were gradually ignored. The emphasis shifted from community based surface water storage structures, to individual investments which exploited ground water.

Pigeon pea is a tropical grain legume grown mainly in India. Though largely considered an orphan crop, pigeon pea has a huge untapped potential for improvement both in quantity and quality of production. More than any other legume adapted to the region, pigeon pea uniquely combines optimal nutritional profiles, high tolerance to environmental stresses, high biomass productivity and most nutrient and moisture contributions to the soil. The legume can be utilized in several diverse ways while the high genetic variability that exists within the cultivated and wild relatives remains to be explored for further uses. This article highlights the need for popularizing pigeonpea as a major legume crop in India.

Ponds help to recharge groundwater. Whether filled with water diverted from a stream or with tail water from irrigation, clay-lined ponds seep water into the ground at highly variable rates.

Ponds can assist in flood control by capturing and slowing the flow of water through a watershed. Particularly as climate change leads to greater storm flows, a distributed network of farm ponds could play an important role in attenuating peak flow and reducing flooding.

A more localized and distributed water supply can offsets water transported from distance reservoirs, reducing the energy needed for water conveyance. The harvested water in farm ponds is being used for providing life saving irrigation to dry land crops by lifting and applying to the fields. In the semi-arid region like Marathwada, the evaporation from water storage structures are generally high due

to high temperature and low relative humidity. Therefore, the present study was undertaken with following objectives, 1. To determine the storage losses from farm pond. 2. To study the effect of protective irrigation on the yield of pigeon pea.3. To study the economic feasibility of farm pond harvested water for protective irrigation.

Materials and Methods

The study entitled 'Studies on rainwater harvesting and reutilization for protective irrigation with farm pond" was conducted at Crop Demonstration Farm, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during the year 2016-2017.The cross sectional area at bottom and top section of the farm pond was found to be 279.75 m^2 and 516.82 m^2 respectively. The mean R.L. of embankment top was 413.130m. The average R.L. of bottom of farm pond was 410.210m. The R.L. of the outlet was 412.437m. The maximum depth of water impounded and storage capacity of pond was 2.227 m and 933.99 m^3 respectively. For determination of water surface area, R.L.s will be recorded at an interval of 0.25 m interval starting from the top of embankment, to develop water spread area- stage relationship. Lateral measurements on inside side slope of the farm pond were simultaneously recorded with respect to each vertical interval. Storage volume with respect to each vertical interval in farm pond will be determined by using Trapezoidal formula. Water stage in the farm pond will be measured with the help of staff gauge installed in the farm pond. Observations on depth of water impounded in the farm pond will recorded daily. The corresponding storage volume was determined by developing stage-storage relationship of the farm pond. Major storage losses from stored water in the farm pond are evaporation and seepage. For estimation of evaporation loss; daily pan evaporation data recorded at Meteorological Observatory, VNMKV, Parbhani, was used. The evaporation loss through farm pond was calculated by using following formula,

$$\text{Evaporation loss } (m^3/\text{day}) = \frac{\text{Daily pan evaporation (mm)} \times 0.7 \times \text{Average Water surface area, } m^2}{1000}$$

Seepage loss was estimated by subtracting evaporation loss from change in storage volume. Seepage loss from the farm pond was estimated on daily basis and added over the period. The (-) Ve sign indicate the loss in storage volume while (+) Ve sign indicates the increase in storage volume. The harvested water was utilized as source for protective irrigation for pigeon pea and accordingly study was planned. The treatment of recycling study includes some protection irrigation in pod development stage of pigeon pea and compared with treatment without irrigation.

The experimental details are given as below,

Design: CRD (Completely Randomized Design)

Plot size : 2×2 m

Replications: 6

Treatments : 2

T_1 – Single protective irrigation at pod development stage

T_2 – Without any Protective irrigation,

Crop : Pigeon pea (*Cajanus cajan*)

Variety: BDN-779

Date of sowing :20/06/2016

Date of harvesting :25/12/2016
Date of protective irrigation :30/11/2016 (pod development stage)

Depth of protective irrigation : 10cm

Stage of pigeon pea crop : pod development.

For economic evaluation of the treatments, cost of cultivation, cost of cultural operations, fixed and operational costs of pump and accessories were calculated. These total cost was be used to determine the gross monetary returns (GMR), net monetary returns (NMR) and benefit cost ratio (B:C ratio).

The design of the experiment was prepared considering completely Randomized Design. The statistical analysis was carried out with MAUSTAT, standard statistical software for the comparison between the treatment means of growth using F test, standard error of means and the critical differences (CD).

Results and Discussion

Total rainfall received during January to December 2016 was 1159.5 mm in 54 rainy days, whereas the total rainfall received during July to December 2016 was 839.1 mm in 40 rainy days. With respect to the distribution of rainfall during the season, it was observed that July was found as wettest month with 407.2 mm rainfall, followed by the month of September with 171.6 mm rainfall.

From analysis of water balance components of farm pond, evaporation losses were estimated on daily basis using pan evaporation data and have been presented in Table 1. Data presented in Table 1 revealed that during the period from July-December 2016 water loss due to evaporation through the farm pond was maximum of 35.98 m^3 during the month of October followed by 32.60 m^3 during the month of August. Evaporation losses were 19.14, 25.40, 29.86 and 1.19 m^3 for the month of July, September, November and December respectively. Thus, total storage water loss due to evaporation through the farm pond during July to December was observed as 144.17 m^3, which was accounted as 5.57 per cent of total storage losses. Average daily evaporation loss through the farm pond for the months, July, August, September, October, November and December, 2016 was 1.66, 1.05, 0.84, 1.16, 0.99 and 0.085 m^3 respectively (Table 1).

From the observation of Table 1 with respect to seepage loss through the farm pond, it indicated that, during the season July to December 2016, maximum seepage loss of 651.80 m^3 was observed in the month of September, whereas minimum of 37.89 m^3 was observed in the month of December.

The seepage losses for the month of July, August, October and November were 634.88, 358.05, 611.64 and 147.33 respectively. Thus, total storage water loss due to seepage from July to December 2016 was observed 2441.59 m^3, which accounted 94.42 per cent of total storage losses. Average seepage loss for the month of July, August, September, October, November and December, 2016 was observed as 30.12, 11.93, 22.47, 19.73 and 4.91, 2.91 m^3 respectively(Table 1).

Pigeon pea grain under different irrigation treatments is presented in Table 2. It is clear from Table 2 that treatment T_1 (one protective irrigation at pod development stage) gave significantly higher grain control (T_2). It was observed from Table 2 that treat T_1recorded pigeon pea grain yield 881.76 Kg per hectare as compared to treatment T_2 (641.03 Kg per hectare). It was also seen from Table 2 that treatment T_1 showed 27.30 % increase in pigeon pea grain yield over control (i.e. Treatment T_2).

It could be seen from Table 3 that the cost of one protective irrigation per hectare by surface method was worked out to be Rs. 5000/- Fixed and variable costs incurred have been considered while calculating cost of one

protective irrigation.

The economics of protective irrigation to pigeon pea under different irrigation treatments are estimated and presented in Table 4. The cost of irrigation for each treatment is estimated per season considering the life and depreciation cost of pump set, PVC pipes and accessories given in Table 3. Then, the additional cost of one protective irrigation over control is estimated. In table 4, the selling or market rate of pigeon pea is considered and the GMR (Gross monetary returns) is estimated under each treatment. The NMR (Net monetary returns =GMR-(cultivation cost + additional cost of protective irrigation)) is also estimated. The benefit- cost ratio is estimated by dividing the net monetary returns with cost of cultivation.

Data presented in Table 4 shows that, treatment T1 *i. e*. one protective irrigations at pod development stage recorded highest GMR (111302.00Rs/ha) and NMR (76302.00) as compared to control (T2) *i. e.* without protective irrigation. Data presented in Table 4 shows that, the benefit- cost ratio (2.18) is found to be higher under the treatment t1*i. e*. one protective irrigation pod development stage The lowest B:C ratio (1.69) is estimated under the treatment T_2 (without protective irrigation).

Table.1 Average daily evaporation and seepage losses through farm pond Observed during the year-2016, VNMKV, Parbhani.

Month	Total evaporation loss (m^3)	Av. Daily evaporation loss (m^3/d)	Total seepage loss (m^3)	Av. Seepage loss (m^3)
10^{th}- 31^{st}July	19.10	1.66	632.60	30.12
1^{st} - 31^{st}August	32.61	1.05	358.05	11.93
1^{st} - 30^{st}September	25.41	0.84	651.80	22.47
1^{st}- 31^{st}October	35.99	1.16	611.64	19.73
1^{st} - 30^{st} November	29.87	0.99	147.33	4.91
1^{st}-14^{th}December	1.20	0.09	37.89	2.91
Total	144.18	4.13	2439.31	92.07

Table.2 Pigeon pea grain yield affected by protective irrigation during *rabi* 2016 – 17

Treatments	Pigeon pea grain yield (Kg/ ha)	Increase in grain yield over control(%)
T_1- One protective irrigation at pod development stage	2204.41	27.30
T_2- Control (without any protective irrigation)	1602.57	
SE	5.29	
C. D at (P= 5%)	16.88	
Mean	1903.49	
CV %	1.70	

Table.3 Cost of protective irrigation from harvested rain water through farm pond with Diesel run portable pump set.

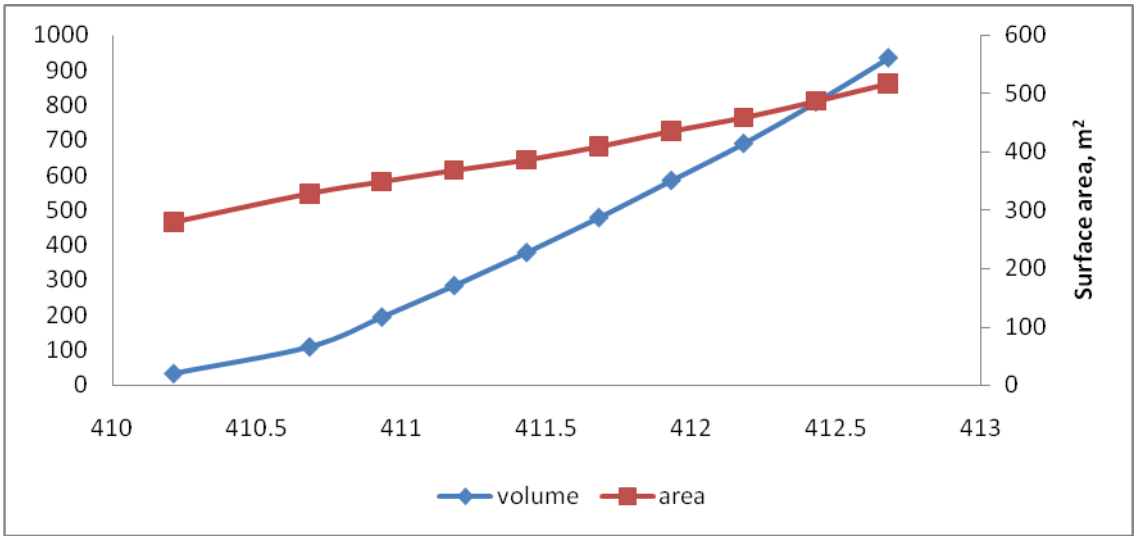
Sr. No.	Particulars	Cost, Rs
Fixed costs / year		
1.	Depreciation cost of portable pump set, 1.5 hp	750
2.	Depreciation cost of PVC pipes and accessories	650
Variable costs/ ha		
1.	Fuel consumption (15 liter diesel)	1100
2.	Labour (10 man days)	2500
Cost of irrigation operation/ ha Rs.5000		

*Excluding the cost of excavation of farm pond

Table.4 Pigeon pea yield and cost economics as affected by protective irrigation

Treatment	Pigeon pea grain yield, kg/ha	Gross Monetary Returns, Rs/ ha	Net Monetary Returns, Rs/ ha	B:C ratio
T_1- One protective irrigation at pod development stage	2204.41	111302.00	76302.00	2.18
T_2- Control (without any protective irrigation)	1602.57	80926.00	50926.00	1.69

Fig.1 Stage storage relationship of the farm pond VNMKV, Parbhani



The research on, 'Studies on rainwater harvesting and reutilization for protective irrigation with farm pond' was conducted during the year 2016-17 at demonstration farm of the Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The daily depth of

water impounded in the farm pond was recorded for developing stage-storage relationship of the farm pond. Daily rainfall and pan evaporation data was collected from the Meteorological Observatory of the Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. For estimation of the loss of water through evaporation from farm pond, daily pan evaporation data was multiplied by pan co-efficient (0.70). The daily water loss through evaporation (m^3) from the farm pond was calculated by multiplying daily depth of water evaporated from the farm pond to the water storage area for a particular day. The daily water storage area and volume of water impounded was estimated for particular depth of impounding of water from stage storage relationship of the farm pond.

The harvested water in the farm pond was utilized for applying protective irrigation to the pigeon pea crop. The experiment consisted six replications and two treatments. One protective irrigation for pigeon pea at pod development stage (T_1) was applied on 30.11.2016. The treatment T_2 consisted without protective irrigation to pigeon pea. The grain yield of pigeon pea was recorded plot wise. The grain yield data was analyzed using MAUSTAT software and results obtained were compared treatment wise.

For economic analysis of the treatments, cost of cultivation, cost of cultural operations, fixed and operational costs of pump and accessories were calculated. These total cost was be used to determine the gross monetary returns (GMR), net monetary returns (NMR) and benefit cost ratio (B:C ratio).

The area of top section and bottom section of the farm pond was 279.75 m^2 and 516.82 m^2 respectively. The average elevation of embankment at top was 413.130m. The average elevation of bottom of pond was 410.210m. The elevation at the bottom of outlet was 412.437m. The maximum depth of water impounded and maximum storage volume in the farm pond was 2.165m and 933.99m^3 respectively.

The total water evaporated through farm pond for the month of July, August, September, October, November and December 2016 was found to be 19.14 m^3, 32.60m^3, 25.40 m^3, 35.9882m^3,29.8620m^3 and 1.1965 m^3 respectively. The maximum water evaporated through the farm pond was recorded in the month of October-2016. Total evaporation loss through the farm pond recorded was144.17 m^3.The seepage loss through the pond for the month of July August, September, October, November and December 2016 was found to 634.88, 358.05 m3, 651.80 m^3, 611.64 m^3, 147.33 m^3, and 37.89 m^3 respectively. The maximum water seepage through the farm pond was recorded in the month of September -2016.The total seepage loss recorded through the farm pond was 2441.59 m^3.

The harvested water in the farm pond was utilized for irrigating the pigeon pea crop at its pod development stage. One of protective irrigation (T_1) recorded significantly higher pigeon pea grain yield than treatment of without protective irrigation (T_2). Due to the one protective irrigation, 27.30 per cent grain yield increased over or control was observed.

The study revealed that the treatment T_1 *i. e.* one protective irrigations at pod development stage recorded highest GMR (111302.00Rs/ha) and NMR (76302.00) as compared to control (T_2) *i. e.* without protective irrigation. The benefit- cost ratio (2.18) is found to be higher under the treatment T_1 *i. e.* one protective irrigation pod development stage. The lowest B:C ratio (1.69) is estimated under the treatment T_2 (without protective irrigation).

It is very clear that, the farm pond constructed at the demonstration farm of Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani provided sufficient water during 2016 season. From the results obtained in present study, following conclusions are drawn,

The evaporation and seepage loss component from unlined dug out type farm pond was found to be144.18 m^3 and 2439.31 m^3respectively during the water storage period (10^{th}July to 14^{th} December). Total rain water harvested in the farm pond for the period 10^{th} July to 14^{th} December 2016 was found to be 2585.76 $m^{3.}$ Seepage losses comprise 94.33 % of storage losses indicating the need to line the farm pond. Seepage losses were decreased as the storage time elapsed. They were found maximum in the month of July.

Treatment of one protective irrigation (T_1) recorded significantly higher grain yield (2204.41 Kg/ha) than treatment of without protective irrigation (T_2) (1602.57 Kg/ha). The study thus, has been able to throw the light on, advantages of protective irrigation through farm pond.

In case long duration *kharif* crop like pigeon pea, when the conserved moisture in the soil was not adequate, one irrigation provided from the farm pond increased the pigeon pea crop yield by 27.30 per cent. The benefit- cost ratio was found to be higher under the treatment T_1 *i. e.* one protective irrigation pod development stage than T_2 (without protective irrigation).

The observations and the results of the study showed that farm pond is an effective technology for harvesting and recharging the runoff thereby providing water for protective irrigation.

The study has been useful for further development of farm pond technology to make it more profitable.

References

Bhandarkar, D. M., K. S. Reddy, water harvesting and recycling technology for sustainable agriculture in vertisols with high rainfall. Vol. 276 – 289.

Desai Rajashwari, B. L. Patil, L. B. Kunnal, H. Jayashree, H. Basavaraj (2007). Impact assessment of Farm ponds in Dharwad district of Karnataka. Karnataka J. Agric. Sci. Vol. 20: 426-427.

Goyal, R. K., P. R. Ojasvi and T. K. Bhati (1995). Economic evaluation of water harvesting pond under arid conditions. *Indian Journal Soil Conservation* Vol. 23 (1): 74-76.

Grewel, S. S., M. L. Luneja, L. N. Debey and M. Chandrapa (1982). Effect of some soil and site properties on seepage losses from harvested runoff water in small storage reservoirs *J. Agril. Engg*. Vol. 19 (4): 63-70.

Hadda M. S. and R. P. Yadav (2009). Impact of small rain water harvesting tanks on agriculture and livelihood of farmers. *Journal of Soil and Water Conservation* Vol. 8 pp. 33-36.

Juyal, G. P. and R. K. Gupta (1985). Construction of LDPE lined TANKAS in hills – A case study Indian Journal Soil Conservation13(1) : 10-13.

Kale, S. R., J. R. Ramteke, S. B. Bordrekar and P. S. Chopra (1986). Effect of various sealant material on seepage losses in tanks in lateritic soil 14 (2) :*Indian Journal Soil Conservation* Vol. 14 (2) : 58-59.

Khan, M. A. (1992). Evaporation of water from free water surface climatic influence *Indian Journal Soil Conservation* Vol. 20: Nos 1 & 2 pp. 26-27.

Mann, H. S. and B. V. RamanaRao (1981). Rain water harvesting, management and its implications. *Indian Journal*

Soil Conservation Vol.9 No. 2 & 3.

Mathur, C. P. G. Sastry, S. P. Bhardwaj and A. K. Khular (1997). Runoff and sedimentation studies for water harvesting structures in doon valley. *Indian Journal Soil Conservation* Vol. 25 (2): pp. 96-102.

Mishra, P. K., C. A. Rama Rao and S. Siva Prasad (1998). Economic evaluation of farm pond in a micro-watershed in semi-arid alfisoldeccan plateau. *Indian Journal Soil Conservation*, Vol. 26 (1) : pp.59-60.

Palanisami K. (1991). Economic evaluation of percolation ponds in Tamil Nadu State *Indian Journal Soil Conservation*, Vol.19: 1-2.

Pendke M. S., Bhuibhar B. W., and Kamble A. M. (2014). Rainwater Harvesting and Recycling for Sustainable Agriculture in Assured Rainfall Zone of Marathwada Region, Maharashtra., Indian journal. Dryland Agriculture Resources & Dev. 29(2) : 12-16.

Rana, D. S., Bharat Bhushan and S. S. Grewal (2006). Economic evaluation of water harvesting structures in Himachal Pradesh. *Indian Journal Soil Conservation*, Vol. 34 (2): 134-139.

Rana, R.S. and Manoj Gupta (2010). Impact assessment of rainwater harvesting tanks in hilly areas. *Indian Journal Soil Conservation* Vol. 38 (2): 137-141.

Rana, R. S., Manoj Gupta and H. L. Thakur (2009). Rain water harvesting through silpaulin lined tanks in hilly areas. *Indian Journal Soil Conservation* Vol. 37 (1): 37-40.

Ranade,(2014) D. H., Ram K., Gupta, L. K. Jain and D. K. Mccool (1993). Comparative performance of different sedlent material for seepage control. *Indian Journal Soil Conservation* Vol. 21 (2) : 1-5

Sastray, G. and Gurumel Singh (1993). Water harvesting and recycling engineering aspects. *Indian Journal Soil Conservation* Vol. 21 (2) : 40-45.

Samindre M. S.(2011). Assessment of farm pond with respect to water harvesting and recycling. Unpublished Thesis, VNMKV, Parbhani.

Singh, A. K., Ashok Kumar and V. S. Katiyar (1998). Performance of different sealants for seepage control in eco-regions of India. *Indian Journal Soil Conservation* Vol. 26 (1) :pp 39-43.

Tiwari, K. N. (1991). Rainwater harvesting technology. *Indian Journal Soil Conservation* Vol. 19 (3) : 37-44.

Vora, M. D., H. B. Solanki and K. L. Bhoi (2008). Farm pond technology for enhancing crop productivity in Bhal area of Gujarat. *Journal of Agricultural Engineering* Vol. 45 (1): 40-46.

Yadav, R. P., R. K. Aggarwal, S. L. Arya, A. K. TIwari and Ram Prasad (2006). Partial polythene lining for reduced seepage losses from farm ponds *Indian Journal Soil Conservation*, Vol. 34 (2): pp. 118-122.

How to cite this article:

More Ram, M., D. Jagtap Raghunath, R. More Madhukar and Harkal Anil, D. 2021. Studies on Rainwater Harvesting and Reutilization for Protective Irrigation with Farm Pond. *Int.J.Curr.Microbiol.App.Sci.* 10(09): 375-383. doi: https://doi.org/10.20546/ijcmas.2021.1009.043