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Planning and design of plastic lined farm pond

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Abstract
Water is one of the most important natural resources and all forms of life are dependent on it. Rainfall in drought prone area is highly erratic storage must be an integral part of any rainwater harvesting system. Plastic lined farm pond is the best option for providing supplemental irrigation and to enhance productivity. The present study consists of three parts. Estimation of peak runoff rate, estimation of runoff volume, estimation of cost of plastic lined pond for different capacity. These scrutinized data were then grouped into weeks (total 17 weeks) and finally two days maximum rainfall values were selected from each week. We designed plastic lined pond of 2000 m^3 capacity for catchment area of 30 ha, 40 ha, 50 ha, for which values of estimated peak runoff rate were 4.62 m^3/sec, 5.73 m^3/sec, 7.77 m^3/sec and volume of runoff were 4.137 ha-m, 5.512 ha-m, 6.890 ha-m respectively and total cost for design of plastic lined pond rates as per BSR, 2013-2014, Panchayat Samiti, Girwa (Udaipur) was Rs. 5,88175. All in all, considering the benefits accuring from the implementation of the project and during the life time of the structure (10-15 years) it can be safely said to be beneficial.

Keywords: peak runoff rate, catchment area, plastic lined, farm pond

Introduction
Water is one of the most important natural resources and all forms of life are dependent on it. It is, therefore, very essential to properly conserve and manage this resource and regulate its use to obtain maximum benefits. Precipitation is the most important source of fresh water and there is need to manage the rain water so as to reduce the impact of moisture stress and obtain sustainability in agricultural production. Out of 400 million ha-m precipitation in the country, 70 million ha-m is consumed as evapotranspiration, 215 million ha-m infiltrates into soil, whereas 115 million ha-m is lost as run-off, resulting in drought in the catchment and flood downstream. Harvesting of one forth of this 115 million ha-m run-off water in farm ponds can provide three irrigations to the entire rain fed area, which constitute two third of cultivated land of the country. Harvesting of rainwater through surface storage is one outlet to combat the situation. Construction of farm ponds in individual farmer's field or on community basis for harvesting of run-off water when it is in excess and recycling of stored water for irrigation and other purposes when there is deficiency of water is a very effective and efficient method of facing the challenge of water scarcity in rain fed areas (Michael, 1978) [16]. Plastic lined farm ponds are particularly suitable for those areas where large quantity of water is lost through seepage, especially where the soil is gravelly and porous. In earthen dams there is also a common problem of seepage through the embankment. Under such circumstances, to check the seepage from all such types of farm ponds.

India is a traditional user of ponds, these are small water bodies either man-made or natural which have been use since ages. They are traditional water harvesting structures and the water stored in these structures is commonly used for drinking water supply, washing / bathing for human and animals, irrigating crops and raising the fish. These small water bodies also play an important role in improving the ecological system and help to maintain biological diversity. In India, approximately 25 lakh ponds are used for a variety of applications. The traditional areas of ponds are in Andhra Pradesh, Karnataka, Tamil Nadu, Orissa and Madhya Pradesh. Ponds are located on a variety of soil type, which exhibit a wide range of seepage characteristics. The seepage losses in some soil types are as high as 11 m3/s/ per million square meter area. Seepage losses not only mean loss of useful water but it also leads to other problems such as trench in the embankments, water logging or increased salinity in the adjacent area. centuries and considerable work has been reported on farm-scale reservoirs or farm ponds (Helweg and Sharma, 1983; Verma and Sarma, 1990; Srivastava, 1992; Singh and Kumar, 2007) [17, 19, 22, 21].

The role of water harvesting systems in semiarid and arid zone is to provide life saving irrigation to low duty crops in the monsoon season and if possible one or two irrigations to raise another crop in the following dry season.

However, in sub-humid/humid high rainfall regions, the runoff recycling should aim to provide a sufficient water supply to rice in conjunction with rain during the wet season and supplementary irrigation to a low duty crop in the subsequent dry season (Bhatnagar *et al*, 1996) [20]. Similarly, in canal command area a rapid decline of available irrigation water has been observed in many parts of the country due to increasing demand for water from non-agricultural sector (Singh and Kumar, 2007) [21]. Thus water for irrigation is becoming both scarce and expensive, particularly in arid and semiarid parts of the country. The problem is aggravated when ground water is saline and not fit for irrigation use. Secondary reservoirs are storage structures (ponds) located in irrigated areas that allow farmers to store a part of canal water and use it judiciously (Singh and Kumar, 2007) [21]. 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 (Kumar *et al*, 2008). Further, The Hill and Mountain agro-ecosystem of the country is characterized by very low acreage under irrigation and difficult terrain conditions. The problem in this area is aggravated with sloping characteristics of the terrain and shallow soil depth which allows major portion of rain water to be lost as run-off (Kumar *et al*, 2007) [21]. Crop failure is common event for want of pre-sowing irrigation, if rain is not received at sowing time of the crops. The alternate mean of irrigation in uplands are exploitation of small spring and rainwater collected to the impermeable tanks or ponds (Srivastava, 1992; Bhatnagar *et al*, 1996 and Kumar *et al*, 2007) [22, 20, 21]. The LDPE film lined tanks has been found as one of the best option for water storage in order to maximize water availability for irrigation.

Material and Methods

Study Area

In terms of area, Rajasthan is largest state in country occupying 3,42,000 square kilometers area. It has 33 districts and situated between 69°30' to 78°17'E longitude and 23˚30'to 30˚12' N latitude. Climate of Rajasthan in northwestern India is usually arid to semi-arid with hot temperatures over the year with extreme temperatures in both summer and winter. The state has two different epoch of rainfall, one is due to the South-West Monsoon after summer and another rainfall due to Western Disturbances.

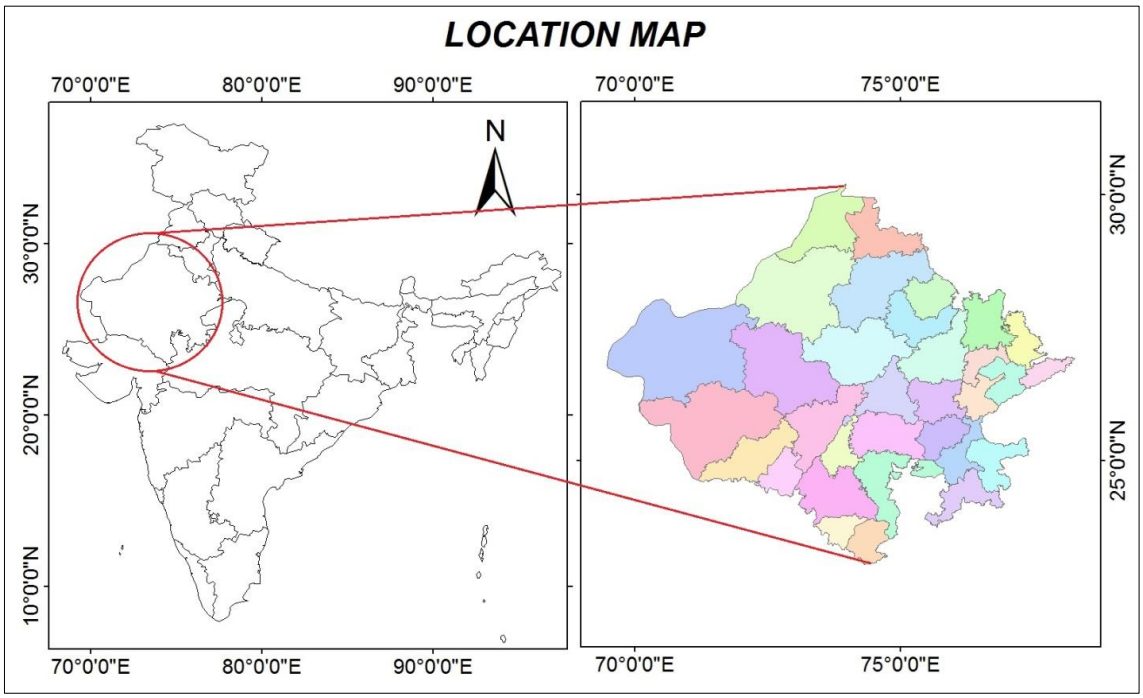

Fig 1: Location map

1.1. Selection of Catchment for a Farm Pond

For locating a farm pond selection of catchment is extremely important for several reasons. It is selected on the basis of its potentiality for yielding sizeable quantity of runoff. Because may not bring in enough water into the pond. The runoff amount from different catchment will depend on several factors.

Factor governing amount of runoff

Rainfall

a. Rainfall intensity
b. Rainfall duration
c. Rainfall distribution
d. Events of rainfall causing runoff

Land topography

a. Degree of land slope
b. Length of run
c. Size and shape of the catchment
d. Extent of depression and undulations on the catchment

Soil type

a. Soil infiltration rate
b. Antecedent soil moisture
c. Soil texture
d. Soil structure
e. Soil erodibility characteristics

Land use pattern

a. Cultivated or uncultivated or partially cultivated
b. Under pasture of forests
c. Bare fallow or with vegetation
d. Soil and moisture conservation measures adopted or not
e. Crop cultural practices that are adopted

Site Selection for Farm Pond

The plastic lined pond are designed and constructed in the areas where soils are porous and seepage losses from the ponds are very high. These structures are also constructed in the area where groundwater is saline and there is need to store the harvested surface water for longer duration to fulfill the agricultural as well as domestic requirement. The selection of a suitable site for the location of a farm pond should depend on the following preliminary considerations:

1. Good command area with level land requiring little or no land shaping should be available near the pond,
2. It is a advisable to locate the pond at elevation differences between two fields or in a valley portion or depression which favours storage excavation ratio and facilities for gravity flow irrigation,
3. The catchment of the pond should be well protected for arresting rapid siltation,
4. This would mean that the catchment should have well laid out bunds and all other agronomic measures of soil conservation like contour cultivation, contour strip cropping, crop rotation *etc*.,
5. The pond should be so selected that the catchment size is optimum,
6. Consideration should be given to the impounding effect of soil conservation measures while deciding the capacity of the farm pond,
7. The construction of runoff harvesting ponds involves consideration of yield of catchment, storage available at site water requirement for project need and ground water conditions,
8. Any type of pond, irrespective of its purpose, should be located on one side the water course and not in the water course itself to avoid rapid siltation,
9. When soils of different permeability occur is succession, it is then feasible to locate it in soils with low permeability to minimize seepage losses, and
10. Ponds in shales, basalt or on shattered rocks are likely to loose more water. It is therefore advantageous to know the nature of sub-strata. Trial pits may indicate the nature of sub-strata.
11. The site should be such that a large volume of water could be stored with minimum excavation.

Design of Farm Pond

The design of farm pond involves following steps

Rainfall analysis

It has been investigated that two-day maximum rainfall of any week amounts to 70 per cent of that weeks total rainfall and runoff produced by this rainfall is sufficient to be considered for harvesting into the storage structures (Rao, 2001). The long term daily rainfall data of 30 years are required. These long terms daily rainfalls were scrutinized for monsoon period only. These scrutinized data were then grouped into weeks (total 17 weeks) and finally two days maximum rainfall values were selected from each week.

Estimation of Peak runoff rate

The peak runoff rate should be assessed accurately for designing the recharge structure and may be assessed by the following formula.

Dickens method

Peak rate of runoff (Q) = $CM^{3/4}$ …(1)

Q = Peak rate of runoff, m^3/sec.

C = Runoff coefficient

M = Catchment area, km^2

Estimation of runoff volume

The runoff yield from the catchment area is calculated using the Stranges table.

Design of WHP

An inverted truncated pyramid shape farm pond (dugout) is considered for the design, as it is a most practical shape to be constructed with ease. The side slope is taken as 1:1 or as per type of soil. A depth of 3 to 4 m is suitable in general for ponds (Samra *et al.* 1996) [11]. The bottom of pond is assumed to be square in shape. The estimated runoff is used as a storage capacity of the pond.

Design of Water inlet and Emergency outlet

Water stream is diverted to fill the reservoir, which have enough kinetic energy to damage the reservoir beds. For safe disposal of flowing water to be diverted through pipe or crest to fill. An emergency outlet should also be provided for draining excess water from the pond, in case of excess rain or in flow from. Pipes are fixed at the height of maximum water level of pond to serve the purpose.

Results and Discussion

Estimation of peak runoff rate

Peak runoff rate is estimated by using dicken's method

1. Catchment area - 5 ha
Average annual rainfall – 650mm
Soil type – clay loam
$Q = 11.4 (.O5)^{3/4}$
$= 1.2\ m^3$/sec

2. Catchment area – 10 ha
Average annual rainfall – 650 mm
Soil type – clay loam
$Q = 11.4 (.1)^{3/4}$
$= 2.02\ m^3$/sec

3. Catchment area – 20 ha
Average annual rainfall – 650mm
Soil type – clay loam
$Q = 11.4 (.2)^{3/4}$
$= 3.407\ m^3$/sec

4. Catchment area – 30 ha
Average annual rainfall – 650 mm
Soil type – clay loam
$Q = 11.4 (.3)^{3/4}$
$= 4.62\ m^3$/sec

5. Catchment area – 40 ha
Average annual rainfall – 650 mm
Soil type – clay loam

$Q = 11.4(0.4)^{3/4}$
$= 5.73\ m^3/sec$

6. Catchment area – 50 ha
Average annual rainfall – 650 mm
Soil type – clay loam
$Q = 11.4(0.5)^{3/4}$
$= 7.77\ m^3/sec$

Table 1: estimation of peak runoff rate

S. No.	Catchment area (ha)	Peak runoff rate (m^3/sec)
1	5	1.2
2	10	2.02
3	20	3.407
4	30	4.62
5	40	5.73
6	50	7.77

Estimation of runoff volume
The runoff yield from the catchment area is calculated using the Stranges table
Average annual rainfall- 650 mm

1. Catchment area – 5 ha
Percentage of runoff from the catchment considering good catchment
(Stranges table) – 21.2
Volume of runoff – 0. 6890 ha-m
Capacity of the pond – 200 cum

2. Catchment area – 10 ha
Percentage of runoff from the catchment considering good catchment
(Stranges table) – 21.2
Volume of runoff – 1.378 ha-m
Capacity of the pond – 200 cum

3. Catchment area – 20 ha
Percentage of runoff from the catchment considering good catchment
(Stranges table) – 21.2
Volume of runoff – 2.756 ha-m
Capacity of the pond – 500 cum

4. Catchment area – 30 ha
Percentage of runoff from the catchment considering good catchment
(Stranges table) – 21.2
Volume of runoff – 4.137 ha-m

5. Catchment area – 40 ha
Percentage of runoff from the catchment considering good catchment
(Stranges table) – 21.2
Volume of runoff – 5.512 ha-m
Capacity of the pond – 1000 cum

6. Catchment area – 50 ha
Percentage of runoff from the catchment considering good catchment
(Stranges table) – 21.2
Volume of runoff – 6.890 ha-m
Capacity of the pond – 2000 cum

Table 2: Estimation of volume of runoff

S. No.	Catchment area (ha)	Volume of runoff (ha-m)
1	5	0.6890
2	10	1.378
3	20	2.756
4	30	4.137
5	40	5.512
6	50	6.890

Estimation of cost
The cost of different capacity pond have been work out and given in the table.

Table 3: Cost of Plastic lined pond for different capacity

S. No.	Capacity of pond (m^3)	Cost (Rs.) *
1	200	1,07429
2	500	1,86489
3	1000	3,24771
4	2000	5,88175

* Rates as per BSR, 2013-2014, panchayat samiti, Girwa (Udaipur).

Conclusion
The aforesaid project was carried out with a purpose to reduce seepage losses and to provide the design of plastic lined farm pond of various capacity to collect, store and to fulfill the demand of irrigation potential in agriculture as supplementary irrigation. For completion of the project different methods were used, for estimation of peak runoff rate dicken's method was used. For estimation of volume of runoff stranges table was used.
We designed plastic lined pond of 200 m^3 capacity for catchment area of 5 ha, 10 ha, for which values of estimated peak runoff rate were 1.2 m^3/sec, 2.02 m^3/sec and volume of runoff were 0.6890 ha-m, 1.378 ha-m respectively and total cost for design of plastic lined pond rates as per BSR,2013-2014, Panchayat Samiti, Girwa (Udaipur) was Rs. 1,07429.
We designed plastic lined pond of 500 m^3 capacity for catchment area of 10 ha, 20 ha, for which values of estimated peak runoff rate was 2.02 m^3/sec, 3.407 m^3/sec and volume of runoff was 1.378 ha-m, 2.756 ha-m respectively and total cost for design of plastic lined pond rates as per BSR, 2013-2014, Panchayat Samiti, Girwa (Udaipur) was Rs. 1,86489.
We designed plastic lined pond of 1000 m^3 capacity for catchment area of 20 ha, 30 ha, 40 ha, for which values of estimated peak runoff rate were 3.407 m^3/sec, 4.62 m^3/sec, 5.73 m^3/sec and volume of runoff were 2.756 ha-m, 4.137 ha-m, 5.512 ha-m respectively and total cost for design of plastic lined pond rates as per BSR, 2013-2014, Panchayat Samiti, Girwa (Udaipur) was Rs. 3,24771.
We designed plastic lined pond of 2000 m^3 capacity for catchment area of 30 ha, 40 ha, 50 ha, for which values of estimated peak runoff rate were 4.62 m^3/sec, 5.73 m^3/sec, 7.77 m^3/sec and volume of runoff were 4.137 ha-m, 5.512 ha-m, 6.890 ha-m respectively and total cost for design of plastic lined pond rates as per BSR, 2013-2014, Panchayat Samiti, Girwa (Udaipur) was Rs. 5,88175. All in all, considering the benefits accuring from the implementation of the project and during the life time of the structure (10-15 years) it can be safely said to be beneficial.

References
1. Chatterji. Aspects of conservation of Water resources in Rajasthan for water supply. Current trends in arid zone hydrology. Proc. Symp. Study and management of water

resources in arid and semiarid regions. Ahemedabad, April 5-8, 1978, 225-242.
2. Frasier GW. Water harvesting for livestock, wildlife, and domestic use. Prof water Harv. Symp. Phoenix, Arizona, March 26-28, 1974, 40-49.
3. Hillel D. Runoff inducement in arid lands. Final technical report submitted to USDA by Volcani Institute of Agricultural Research and Herbrew University of Jersusalem, Rehoval Israel, Project – Alo-SWC. 1967;36:142.
4. Hollick M. The design of roaded catchments for maximum runoff. Prof. Water Harv. Symp. Phoenix, Arizona, March 26-28, 1974, 201-220.
5. Hollick M. Water harvesting in the arid lands Scientific Review on Arid Zone Research, Scientific publishers, Jodhpur, India. 1982;1:173-247.
6. Murthy KNK, Sharma KD, Vangani NS. Efficient rain water harvesting from arid zone catchments. National, Symp. On Soil and Water Management in 1980's Dehradun, March 12-14, 1980.
7. Myers LE. New water supplies from precipitation harvesting Int. Conf. Water for peace. Washington D.C. 1967;2:631-639.
8. Raghunath HM. Hydrology Principles. Analysis Design. Newage International Publishers Revised Edition, 1996, 453.
9. Rao KK. Investigating on impact of rainfall distribution on runoff estimation using SCS curve number method. M.Sc. Thesis, Division of Agricultural Engineering, IARI, new Delhi, 2001.
10. Sahu RK. Development of water harvesting system for sustainable crop production in micro watershed. Ph.D. Thesis, Division of Agricultural Engineering, New Delhi, 2000.
11. Samra JS, Sharda VN, Sikka AK. Water harvesting and recycling: Indian experiences, ICAR Publication New Delhi, 1996.
12. Sharma KK, Bhattacharya AK. Development of models for designing water harvesting ponds in the rainfed areas. Indian J soil conc. 2005;33(1):27-30.
13. Singh RP. Farm ponds Project Bulletin No. 6 AICRP for Dryland Agriculture, Hyderabad, India, 1983.
14. Tiwari KN. Rain water harvesting technology A review Ind. J. Soil Conservation. 1991;19(3):37-44.
15. Subudhi CR, Senapati SC. water harvesting through the farm pond and utilization of conserved water for veg. in relation to rainfall, 2010.
16. Michael AM. Irrigation: theory and practice. Vikas New Delhi, India, 1978.
17. Helweg O, Sharma N. Optimal design of small reservoirs (tanks). Water Resour. Res. 1983;19(4):881-885.
18. Samra JS, Sharda VN, Sikka AK. Water Harvesting and Recycling: Indian Experiences. Dehradun, India: Central Soil and Water Research and Training Inst, 1996.
19. Verma N, Sharma PB. Design of storage tanks for water harvesting in rainfed areas. Agric. Water Manage. 1990;18(3):195-208.
20. Bhatnagar PR, Srivastava RC, Bhatnagar VK. Management of runoff stored in small tanks for transplanted rice production in mid hills of N-W Himalayas. Agric Water Manage. 1996;30:107-118. DOI: 10.1016/0378-3774(95)01204-4.
21. Singh Rajbir, Kumar S. Plastic Films in Efficient Water Management. (Ed). K.K. Singh *et al*. Kalyani Publisher (Pvt) Ltd, Ludhiana, 2007.
22. Srivastava RC. Design of integrated tank irrigation system for rolling lands using multilevel multiobjective optimization. Unpublished Ph.D. Thesis, Department of Agricultural Engineering, IIT, Kharagpur, 1992.