

MINIMIZING WATER LOSSES IN SMALL RESERVOIR

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ABSTRACT

This study was conducted to determine the effectiveness of carabao manure as lining material, shade net, and wind barrier, in minimizing water losses of small reservoir. Four fish ponds with a dimension of 20 mx 10mx 1m, were used a small reservoir in this study. A compacted 5-cm layer of carabao manure was applied and high density (110 grams/m²) green polyethylene plastic net (50% shade-giving capabilities) was used as shade and wind barrier. Daily measurements of the water level in the ponds were made, including rainfall observation. Results revealed that lining the pond with carabao manure is effective in reducing water storage losses. The use of net as shade or wind barrier alone was not effective in reducing water losses in ponds. On the other hand, the water from the pond lined with carabao manure needs to be analyzed to determine if it is safe for fish production.

Keywords: TSAE2015; carabao manure; water losses; lining material; pond

INTRODUCTION

A small farm reservoir (SFR) is a facility that stores excess rainwater and runoff for use in the field to supplement rainfall in the wet season and to grow a second crop in the dry season. The stored water has become a key strategy against water scarcity under changing climate conditions. The stored water is also used to grow fish which provides additional income to farmers. In Central Luzon, a significant number of SFRs has been used for several years in the rainfed areas.

The need for water as supplementary irrigation during the rainy season is minimal. During this period, precipitation water is harvested in reservoirs to be utilized for growing crops during the dry season. In some areas where water is limiting, water from small reservoir is the main source of water.

A high percentage of water stored from these reservoirs is lost by seepage and percolation. Water losses through seepage and percolation are estimated at 41% or 0.88 m³/day. Many methods of reducing seepage and percolation have been suggested. They include the use of lining materials such as concrete, polymers film, and butyl rubber. Apart from certain problem associated with each of the seepage and percolation control materials, they are generally considered to be

too expensive. There are also other methods that may be advantageous economically, but not as well publicized, which include the use of organic matter liners. A method which appears to have a distinct possibility is based on a gleization process using organic matter liners (Nicholaichuk, 1978). Pondered water is also lost through evaporation from the open surface due to heat and air movement. Wind break and shading are mitigation strategies that can limit the rate of evaporation. Most farmers plant trees around the reservoir to reduce loss of water by evaporation.

During the pilot testing of SFR in Tarlac, farmers constructed the SFR even on soils that have low water holding capacity. Some reservoir users cited that among their major problems were seepage, percolation, and evaporation losses (De Guzman, 2012). As a result, some of the farm ponds did not function as intended in terms of storing adequate water as the stored water only lasted for short periods of time after the rains. Hence, limited portion of the farm can be cultivated during the dry season because of reduced availability of stored water. Therefore, the need to develop technologies to minimize water losses in small reservoirs can be an effective way towards increasing the productivity and income of rainfed farmers. Hence, the study aimed to

minimize the water losses in small reservoirs. Specifically, it aimed to determine the effect of carabao manure, used as lining material, in reducing water storage losses in small reservoir and to determine the effect of shade net and wind barrier in reducing water storage losses in small reservoir.

MATERIALS AND METHOD

Conceptual Framework

One of the challenges in using and managing small reservoir is how to minimize the losses (Bhuiyan, et al., 1994). The study was directed towards this endeavor. The conceptual framework of the study is shown in Figure 1. The input involved use of fish ponds as SFRs; the utilization of carabao manure as lining material for the pond bed; and, the adoption of net as shade and wind barrier. In addition, manual labor in preparing the pond, applying the carabao manure, and installing of net shade and wind barrier was included in the input. A field experiment was conducted to evaluate the effectiveness of using lining material, wind barrier, and shade in reducing the total amount of water losses.

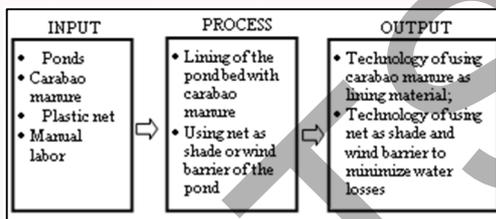


Fig.1. Conceptual framework of the study

Field Experimental Set-up and Design

Four existing fish ponds from the FAC, CLSU were used as the experimental reservoirs. Each pond has a length of 20 m, a width of 10 m, and a depth of 1 m. Runoff was prevented by enclosing the reservoir with a dike. The study has three phases as described below

Phase I- Carabao Manure as Lining Material in Ponds

Phase I of the experiment was focused on the effect of using carabao manure in reducing water losses. Carabao manure was used as lining material in the bottom of two ponds, while the remaining two ponds were not lined to serve as control (Figure 2). Hence, there were two replications (R₁ and R₂) each for the following treatment:

- T₁ – no lining, no shade net, no wind barrier, (control)
- T₂ – with lining, no shade net, no wind barrier

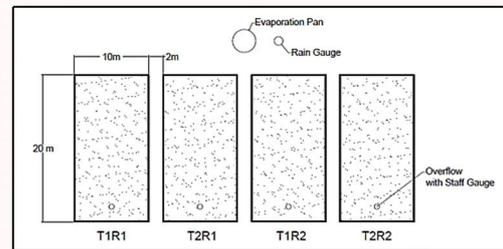


Fig.2. Phase I experimental set-up

Pond Preparation

The bottom of the four ponds was manually leveled. Vegetation and rocks were removed from the ponds. The beds of two ponds were applied with a mixture of carabao manure and water to maintain the consistency of the lining. The mixture was then compacted to a depth of 5 cm. The lining was allowed to settle and dry for one week before the ponds were filled with water using a water pump.

Phase II- Carabao Manure as Lining Material in Ponds with Shade net

For Phase II of the experiment, high density (110 grams/m²) green polyethylene plastic net with 50% shade-giving capability was installed above the surface of the pond to provide shading. The net was placed at 2 m above the pond surface using bamboos as frames and at a distance of 0.5 m from the banks of the pond. The following treatments were applied:

- T₁- no lining, no wind barrier, no shade net (control pond)
- T₂- with lining, no shade net, no wind barrier
- T₃- with lining, with shade net, no wind barrier
- T₄- no lining, with shade net, no wind barrier

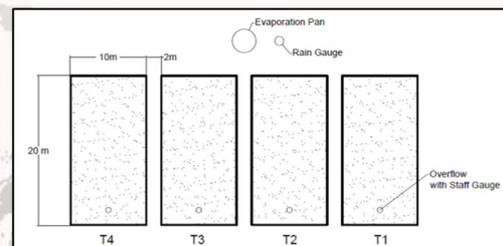


Figure 3. Phase II experimental set-up

Phase III- Carabao Manure as Lining Material in Ponds with Wind Barrier

Under phase III of the experiment, plastic net with a height of 2 m was installed as wind barrier along the perimeter of the pond. The wind barrier was constructed at a distance of 0.5 m from the banks of the pond. The following treatments were imposed:

- T1- no lining, no shade net, no wind barrier, (control)
- T2- with lining, no shade net, no wind barrier
- T5- with lining, no shade net, with wind barrier
- T6- no lining, no shade net, with wind barrier

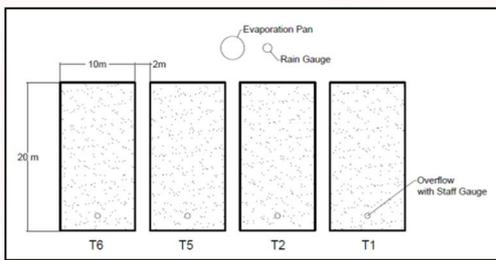


Figure 4. Phase III experimental set-up

Data Collection and Analysis

Daily monitoring of the change in water level was done hourly at 7 o'clock in the morning. The changes in water level were converted into daily change in water storage.

The change in water storage or the sum of the seepage, percolation and evaporation was computed as:

$$\Delta S = D_1 - D_2 - R \quad \dots(1)$$

where:

- ΔS - daily change in water storage, cm
- D_1 - depth of water in the pond on the previous day, cm
- D_2 - depth of water in the pond on a given day, cm
- R - rainfall depth that occurred between D_1 and D_2 , cm

The amount of water saving (%) was determined by comparing the water losses for a given pair treatments. The following equation was used:

$$\text{Water Savings} = (d_A - d_B) / d_A * 100 \quad \dots(2)$$

where:

- d_A - total depth of water removed in the Pond (1), cm

d_B - total depth of water removed in the Pond (2), cm

The number of days needed for the pond to be empty was computed using the following equation:

$$D_n = d / \Delta S_a + d_n \quad \dots(3)$$

where:

- D_n - number of days needed for the pond to be empty
- d - water depth during the last day of observation, cm
- ΔS_a - average change in water storage, cm
- d_n - number of observation days

RESULTS AND DISCUSSION

Phase I-Effect of Carabao Manure as a Lining Material in Reducing Storage Losses

The changes on water storage in the ponds lined with carabao manure (T_2) and in the unlined ponds (T_1). The daily changes in water storage from the ponds with carabao manure as lining were consistently lower than in the ponds that were unlined. These data were statically analyzed and results showed that lining the ponds significantly reduced the combined amount of seepage, percolation and evaporation losses.

The average daily change in water storage in the lined and unlined ponds were 2.2 cm and 3.2 cm respectively. These values were used to estimate the time that the ponds will be empty, assuming that the same weather conditions will prevail, and that no rainfall will occur.

Using the average change on water storage, as reflected in Figure 5, the unlined ponds will be empty after 25 days while those ponds with carabao manure as lining are projected to be dry after 37 days. Also, a water saving of 29.05% was obtained from the lined pond.

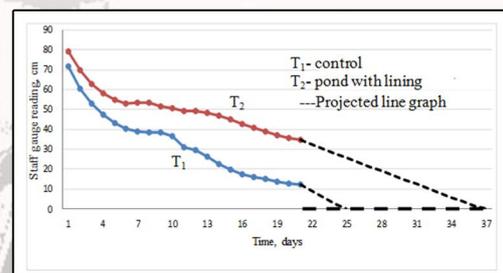


Figure 5. Daily staff gauge reading in the lined and unlined ponds

Phase II- Effect of Carabao Manure as Lining Material in Ponds with Shade Net

Lined and Unlined Ponds with and without Shade Net

No significant difference was found between the daily changes on water storage from lined ponds with and without shade net T₃ vs. T₂. Likewise, the changes on storage in the unlined pond with shade net did not significantly differ with the unlined pond without shade net T₄ vs. T₁. This means that covering the surface of the pond with shade net did not help in reducing water losses.

Lined and Unlined Ponds with Shade Net

Results of the study revealed that there was a significant difference on the daily water storage changes between the lined and unlined ponds with shade net, T₃ vs. T₄. This means that there would be less water losses by lining the pond with carabao manure and covering it with shade net than by only protecting the pond with a shade net. Water saving of 31.77% could be achieved in this manner. In addition, water in the lined pond with shade net is expected to last for 24 days while the unlined pond with shade net will be empty after 17 days.

Lined and Unlined Ponds without Shade Net

There was a highly significant difference found in the change on water storage between the lined and unlined ponds without shade net, T₂ vs. T₁. These findings affirmed the result of the Phase I study. In addition, lining the pond with carabao manure gave water saving of 34.31%. Water stored in the lined pond without shade net will last for 23 days while unlined pond without shade will be empty after 16 days (Figure 6).

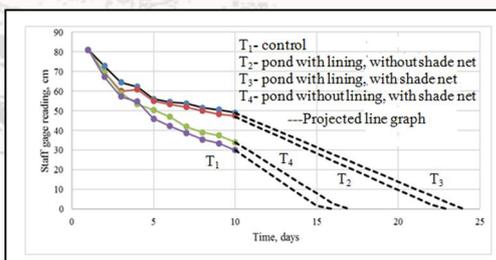


Figure 6. Daily staff gauge readings in the lined and unlined ponds with and without shade net

Lined Ponds with Shade Net vs Unlined Ponds without Shade Net

The daily water loss in the unlined pond without shade net was significantly higher than in the lined pond with shade net, T₁ vs. T₃. This means that the use of carabao manure, as lining, and shade net helped significantly in reducing the water losses in the pond.

When the pond is lined and protected with shade, the stored water in the pond is expected to last for 24 days, as shown in Figure 6. On the other hand, water in the unlined pond without shade net will be dry in just 14 days.

Water saving 37.25% was obtained from the lined pond with shade net against the unlined ponds without shade net.

Lined Pond without Shade Net vs Unlined Pond with Shade Net

No significant difference was found in the change in water losses between the lined pond without shade net (T₂) and unlined pond with shade net (T₄). This means that covering the pond with shade net and lining the pond with carabao manure gave similar effect on water removal from the pond.

Phase III- Effect of Carabao Manure as Lining Material in Ponds with Wind Barrier

The extrapolated changes in water surface elevation in the pond with carabao manure as lining and the unlined pond with and without wind barrier are shown in Figure 7.

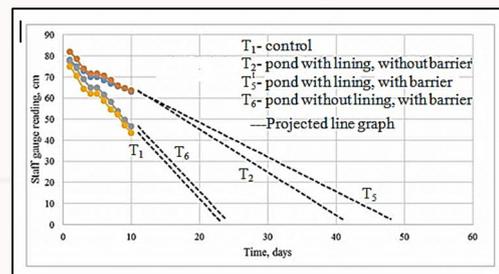


Figure 7. Staff gauge readings in the lined and unlined ponds with and without wind barrier

Lined and Unlined Ponds with and without Wind Barrier

The comparison of means for the lined and unlined ponds, with and without wind barrier T₅ vs. T₂ and T₆ vs. T₁, were found to be not significantly different. This means that providing wind barrier to the lined and unlined ponds is not an effective method to reduce total water losses.

Lined and Unlined Ponds with Wind Barrier

There was a highly significant difference found between the changes on water storage in the lined and unlined ponds with wind barrier, T₅ vs. T₆. This means that there would be more efficient reduction in water losses in the pond by lining the pond with carabao manure and protecting it with wind barrier than by only installing a wind barrier around it. In addition, based on Figure 7, water in the lined pond with wind barrier will last for 48 days while stored water in the unlined pond will be emptied after 24 days. Moreover, water saving of 52.87% was attained in the lined pond with wind barrier.

Lined and Unlined Ponds without Wind Barrier

Results revealed that there was a highly significant difference found in the change on water storage between the lined and unlined ponds without wind barrier, T₂ vs. T₁. This outcome also conformed to the result of Phase I and II of the experiment. Water stored in the lined pond without wind barrier will last for 41 days while the water stored in the unlined ponds without wind barrier are expected to last for 23 days (Figure 7). When compared with the control pond, water saving of 41.40% was attained in the pond lined with carabao manure.

Lined Ponds with Wind Barrier vs Unlined Ponds without Wind Barrier

The changes on water storage in the unlined pond without wind barrier were significantly higher than in the lined ponds with wind barrier, T₁ vs. T₅. This means that the combined use of carabao manure as lining material and net as wind barrier helped significantly in reducing the water loss in the pond.

Based on Figure 7, water in the lined pond with wind barrier is expected to last for 48 days. On the other hand, water in the unlined pond without wind barrier will be emptied in 23 days.

Moreover, lining the pond bed with carabao manure and protecting with wind barrier resulted to water saving of 52.87%.

Lined Ponds without Wind Barrier vs Unlined Ponds with Wind Barrier

There was a highly significant difference found in the change in water losses between the lined pond without wind barrier and the unlined pond with wind barrier, T₂ vs. T₆. However, the result could not ascertain as to whether the amount of percolation that was saved by lining the ponds was offset by the amount of evaporation since there was no wind barrier placed in the lined pond. The result could not also ascertain as to whether the amount of evaporation loss that was saved by the wind barrier was offset by the amount of percolation in the unlined ponds.

Results suggest that lining the pond bed with carabao manure and then protecting it with shade net or wind barrier could give water savings of about 37.25% and 52.8% respectively.

CONCLUSION AND COMMENDATION

Results suggest that lining the ponds with carabao manure and using net as shade or net as wind barrier are effective in minimizing water losses in small reservoir, thereby increasing the amount of water store. It is recommended that a layer of soil should be placed on top of the carabao manure to avoid the manure in place. The quality of water from ponds lined with carabao manure needs to be analyzed to determine if it is safe for fish production and the use of other organic materials may also be evaluated.

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