The cost of saving farm dam water

Debbie Atkins[1,*] and Erik Schmidt[2]

[1] Lapstone, NSW 2773, Australia
[2] National Centre for Engineering in Agriculture, University of Southern Qld, Toowoomba, 4350, Australia
* corresponding and presenting author, debatkins@live.com.au

Summary

A price can now be put on the cost of lost water from farm dams thanks to an economic Ready Reckoner. The calculator, that estimates costs of evaporation and seepage control methods, is available online with other resources for farm dam management. These resources will give farmers, advisors and consultants access to the latest information.

Background

Australia has in excess of 2 million farm dams storing more than 8,000,000 ML of water. Up to 40% of water is lost from Australian farm dams every year due to evaporation, drainage and seepage. These losses are estimated at more than 1,320,000 megalitres. This water is worth up to $660 million that could have otherwise been used to irrigate crops, boost environmental flows in rivers or provide water to residents each year.

This project funded by National Program for Sustainable Irrigation (NPSI) aimed to improve the quality and availability of information on farm dam management. The target audience was agricultural advisors and consultants, Catchment Management Authorities and Natural Resource Management Boards and farm managers.

The Story

Many people are unaware of methods to measure evaporation and seepage from dams, apart from a 'water in/water out' system. Less is known about the various techniques to reduce evaporation such as physical and chemical covers. All information is on the new website for Farm Dam Management http://farmdammanagement.ncea.biz/.

Information was disseminated through workshops, field days, media, conference presentations and posters. Over 240 people attended eight events held in Victoria and New South Wales. Advisors made up about half of the audience at workshops and field days.

The economic Ready Reckoner was seen as a valuable tool in deciding whether to invest in evaporation and/or seepage mitigation methods. It led to useful discussion on the value of water – the extra production that could be achieved if water was saved from evaporation and seepage.

The Ready Reckoner uses specific information about climate, soil type and size and type of dam to calculate water loss from evaporation and seepage. It can compare the cost and effectiveness of installing shade-cloths, floating dam covers or chemical monolayers to save this water. http://www.readyreckoner.ncea.biz/ A case study is provided in Appendix 1.

Analysis and commentary

Most participants were not familiar with monolayer technology and were interested in methods to measure evaporation and seepage. At present the cost of physical covers for dams is quite expensive for most farm operators due to the level of demand, so the interest in monolayers was quite high.

The workshops made people aware that they could hire equipment or to employ consultants to measure evaporation and seepage. While the cost seemed high, the value of knowing how much water was being lost and the potential for increased production for any water saved was of interest to people.

Lessons learned

This information was considered valuable by farmers and advisors. Monolayer technology was new to most of the farmers and provided a lot of interest. National Centre for Engineering in Agriculture is continuing their research on monolayer products and application techniques and technologies. www.ncea.org.au

Demonstration of the Ready Reckoner led to reflection and discussion about the value of water in dams and the cost to save this water. It was of great interest as farm managers consider their options in preparing for dry periods. Most people stated in feedback sheets that they would likely use it to assess their own situation.

This new website provides information on:

- Measurement and management of seepage and evaporation
- Calculating costs of managing water losses
- Improving biodiversity
- Assessing options for aquaculture
- Managing water quality, weed and algae

Resources are mainly from primary industry departments in New South Wales, Victoria and Queensland and other private and government sources.

Conclusions

Water loss from farm dams due to evaporation and seepage can be quite extensive and expensive. Improved management of farm dams can increase water available for irrigation and increase the total productivity of a farm. Even a small improvement in dam management can produce large impacts.

Appendix 1 Case study Demonstration for farm dam Lockyer Valley, Queensland

Location : Lockyer Valley, South-East Queensland,

Description : Horticulture,

Result - Rectangular Ring Tank

Evaporation Mitigation System: Impermeable Cover

Water Saved From Evaporation	3 ML Each Year
Cost To Save This Water	$ 589.7 Per ML Per Year
Calculated Storage Volume At Full Supply Level	2.4 ML
Surface Area At Full Supply Level	.2 Ha
Total Cost Of Evaporation Mitigation System At Installation	$ 13,837
Annual Operating And Maintenance Cost	$ 395.3
Annual Seepage Loss(Ml)	.5 ML

Sensitivity Analysis - Cost To Save Water ($/ML)

The two sensitivity analysis tables provide information on how managing your dam differently may affect the cost of saving water.

The **first table** looks at the costs to save water when the dam contains more or less water **(note 10 or 25 units are added to or subtracted from your input in step 3).** In general, you will find that this does not greatly affect the cost of saving water. This is because the surface area, and hence evaporation, does not change dramatically with the water level.

The **second table** looks at the costs to save water if the dam has more or less years where it contains any water **(note 10 or 25 units are added to or subtracted from your input in step 4).** In general, the more years water is held in your dam the lower are the costs to save water. This is because the potential water saved is greater but the capital costs are the same.

Average Amount of Water Stored Per Month (as a % of Total Storage Volume)

Increase/Decrease	ALL Months	Summer (Oct - Mar)	Winter (Apr - Sept)	
- 25%	659.2	631.6	613.7	$/ML
- 10%	615.7	605.8	599.1	$/ML
0%	589.7	589.7	589.7	$/ML
+ 10%	565.9	574.5	580.7	$/ML
+ 25%	533.5	553	567.6	$/ML

Average Percentage of Years that the Storage Contains Water (per month)

Increase/Decrease	ALL Months	Summer (Oct - Mar)	Winter (Apr - Sept)	
- 25%	786.3	699.9	649.9	$/ML
- 10%	655.3	629.3	612.4	$/ML
0%	589.7	589.7	589.7	$/ML
+ 10%	589.7	589.7	589.7	$/ML
+ 25%	589.7	589.7	589.7	$/ML

User Inputs

Rectangular Ring Tank		
Length @ Centerline of Crest	**50**	**meters**
Width @ Centerline of Crest	**50**	**meters**
Corner Radius @ Centerline of Crest	**10**	**meters**
Storage Wall Crest Width	**2**	**meters**
Average Bank Height	**2**	**meters**
Batter Slope of the Storage Inside Wall	**3**	**in 1**
Batter Slope of the Storage Outside Wall	**2**	**in 1**
Full Supply Volume	**2.4**	**ML**
Freeboard	**0.5**	**meters**

Monthly Evaporation Data		
January	236	mm
February	191	mm
March	191	mm
April	146	mm
May	111	mm
June	93	mm
July	105	mm
August	132	mm
September	169	mm
October	205	mm
November	220	mm
December	241	mm
Annual Total	**2040**	**mm**

Average Amount Of Water Stored Per Month (As A % Of Total Storage Volume)

January, February, March, April, May, June, July, August, September, October, November, December **50** **%**

Average Percentage Of Years That The Storage Contains Water (Per Month)

January, February, March, April, May, June, July, August, September, October, November, December **100** **%**

Applicable Seepage Option - I Have Measured The Seepage Loss

Measured Seepage Loss	**1**	**mm/day**
Depth at which Water Seepage Loss was Determined	**5**	**meters**
Saturated Hydraulic Conductivity of the Compacted Soil	**0.3**	**m/yr**
Average Depth of Sealing Soil under the Storage	**3**	**meters**

Evaporation Mitigation System - Impermeable Cover

Efficiency of EMS (Range - 85-100% (90-95% recommended))	**90**	**%**
Capital (Upfront) Cost (Range - $3.50-$30.00/m2)	**$ 7**	**per m2**
Lifespan (~ 10-15 years recommended)	**15**	**years**

Annual Operating and Maintenance Cost (~ $0.01 - $0.03/m2 recommended) **$ 0.2 per m2**

Evaporation Mitigation System - Evaluation

The table aims to give an initial guidance on which of the 5 evaporation mitigation systems may suit your situation. This will assist you in deciding which systems to get site -specific information on the performance and costs. The two values ($/ML) give the range of costs to save water from the best to worst. It uses the dam and evaporation data entered and assumptions about the performance and cost of the options as outlined below.

Evaporation Mitigation System	Performance	Cost	Cost to Save Water ($/ML)
Impermeable Cover	Good	Low	223.1
	Poor	High	2,638
Shade Cloth	Good	Low	367.4
	Poor	High	2,143.7

Chemical Monolayer	Good Poor	Low 27.5 High 665.3
Modular Cover	Good Poor	Low 143.6 High 3,040.6
Increase Wall Height	Good Poor	Low 133.3 High 1,351.5

- Generally Continuous Impermeable and Shadecloth structures are more appropriate for smaller storages (< 5ha) and where water is more scarce and expensive.
- Generally Modular systems of impermeable and shadecoth material can be used on larger storages than continuous structures.
- Typically monolayer products are most appropriate for large storages (>10ha) although they can be used for smaller storages.
- Increasing wall height is most appropriate when the wall size is small relative to water stored

Assumptions

<u>Impermeable Cover</u>

Good Performance Low Cost

- Efficiency EMS ---------- 95%
- Capital Cost ---------- $3.50/m2
- Lifespan ---------- 15 years
- Annual Operating Cost ---- $0.01/m2

Poor Performance High Cost

- Efficiency EMS ---------- 90%
- Capital Cost ---------- $30/m2
- Lifespan ---------- 10 years
- Annual Operating Cost ---- $0.03/m2

<u>Shade Cloth</u>

Good Performance Low Cost

- Efficiency EMS ---------- 75%
- Capital Cost ---------- $6/m2
- Lifespan ---------- Structure 30 years, Cloth 15 years
- Annual Operating Cost ---- $0.01/m2

Poor Performance High Cost

- Efficiency EMS ---------- 70%
- Capital Cost ---------- $33/m2
- Lifespan ---------- Structure 30 years, Cloth 15 years
- Annual Operating Cost ---- $0.03/m2

<u>Chemical Monolayer</u>

Good Performance Low Cost

- Efficiency EMS ---------- 30%
- Capital Cost ---------- $0.04/m2
- Lifespan ----------Applicator 20 years
- Annual Operating Cost --- $0.004/m2
- Chemical Cost ---------- $8/kg or litre
- Application rate ------- 0.25 kg or l/ha, Applying all year 3 times per month

Poor Performance High Cost

<u>Modular Cover</u>

Good Performance Low Cost

- Efficiency EMS ---------- 90%
- Capital Cost ---------- $2.50/m2
- Lifespan ---------- 20 years
- Annual Operating Cost ---- $0.01/m2

Poor Performance High Cost

- Efficiency EMS ---------- 60%
- Capital Cost ---------- $23/m2

• Efficiency EMS ---------- 5% • Capital Cost ---------- $0.38/m2 • Lifespan ----------Applicator 20 years • Annual Operating Cost ---- $0.01/m2 • Chemical Cost ---------- $15/kg or litre • Application rate ------- 0.75 kg or l/ha, Applying all year 15 times per month	• Lifespan ---------- 10 years • Annual Operating Cost ---- $0.03/m2
<u>Increase in Wall height</u> **Low Cost** • Wall Height increase ---------- 1m • Earthworks cost ---------- $1/m3 • Increased Annual Op Cost ---- $0 **High Cost** • Wall Height increase ---------- 1m • Earthworks cost ---------- $3/m3 • Increased Annual Op Cost ---- $1000	