SNOW FENCING NEAR PIT RESERVOIRS TO IMPROVE WATER SUPPLIES

by

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INTRODUCTION

Building pit reservoirs to provide water for livestock, wildlife, and fisheries is a common practice on open rangelands. Sources of water stored in these reservoirs include streams, springs, wells, and in some situations, drifting snow trapped during blizzards. In low-precipitation years, drifting snow may become the main source of water for ponds at windy locations on the high plains. Drought conditions during 1988-89 in southeastern Wyoming prompted new snow fence construction to capture drifting snow in several reservoirs.

Jairell and Tabler (1985) described small-scale model studies of how interactions between snow fence and embankment locations influence snow deposition in stock ponds. Tabler (1980b) showed the aerodynamic basis for a technique of modeling complex snow drifting situations by placing small-scale models on a smooth surface during ground blizzards with low wind speeds. Tabler and Jairell (1980) demonstrated remarkable agreement between such model predictions and prototype drifts for a wide variety of problems. However, their recommendations regarding location of snow fences and embankments to maximize snow deposition in pit reservoirs were contrary to customary practice, and therefore needed verification. The opportunity to test those predictions arose when deep water wells went dry at several existing pit reservoirs near Laramie, Wyoming. This paper compares results of small-scale modeling and those observed on full-scale stock ponds.

RESULTS

The Jairell and Tabler (1985) recommendations for locating pond embankment and snow fences to accumulate drifting snow, based on model tests, are summarized as follows:

1. Pond embankments constructed from excavated fill should be located downwind, not windward, of the pond, (for prevailing blizzard winds).

2. At existing ponds with windward embankments (the customary practice), deposition can be significantly <u>improved</u> by constructing a snow fence along the top of the embankment.

3. Deposition of drifting snow is <u>maximized</u> by locating a snow fence (of 50% porosity) near the windward edge of a pond with the embankment properly located downwind.

Observations of drift deposition in pit reservoirs during 1990 confirmed each recommendation, as shown by pairs of photographs comparing a Jairell and Tabler (1985) model with a prototype situation. Drift depth at a pond with the embankment downwind showed a shallow accumulation similar to that in the model (Fig. 1). At three ponds, a snow fence located on an embankment upwind of the pond produced snow deposition patterns similar to early stages of deposition in the model (Fig. 2). Photographic records of deposition in 9 pit reservoirs with the embankments downwind, and the snow fence upwind of the pit (Fig. 3), supported the conclusions drawn from the models, that this arrangement worked best, especially in years without much drifting snow. Wind is from the left in each photograph.

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WIND --->

MODEL PROTOTYPE

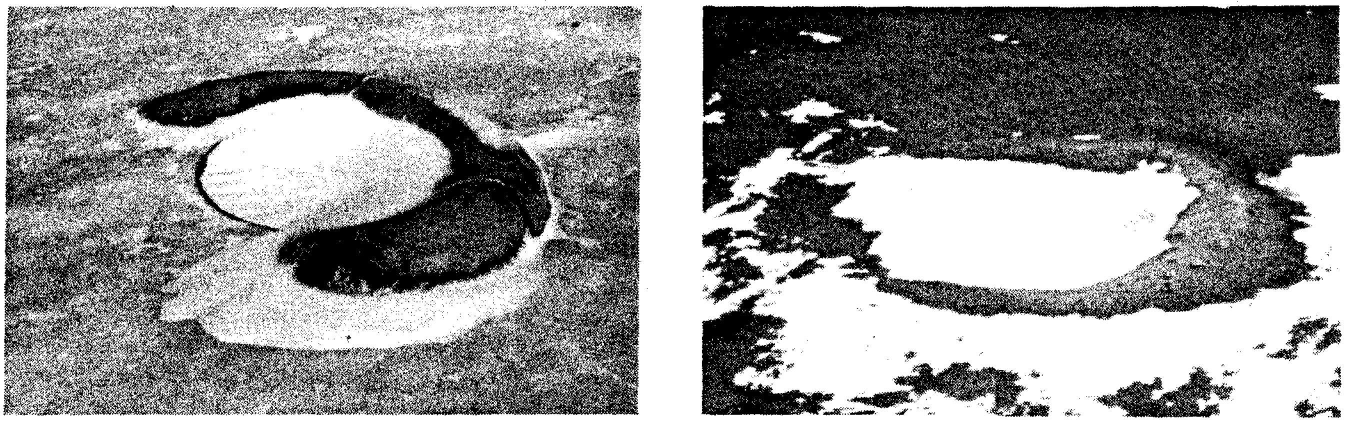

Figure 1. A 1:30 scale model of a pit reservoir 18 m in diameter, with a 3-m embankment downwind, was a better trap for drifting snow than the same model with the embankment upwind (Jairell and Tabler, 1985). The prototype pond shown on the right confirmed the drift pattern predicted by the model.

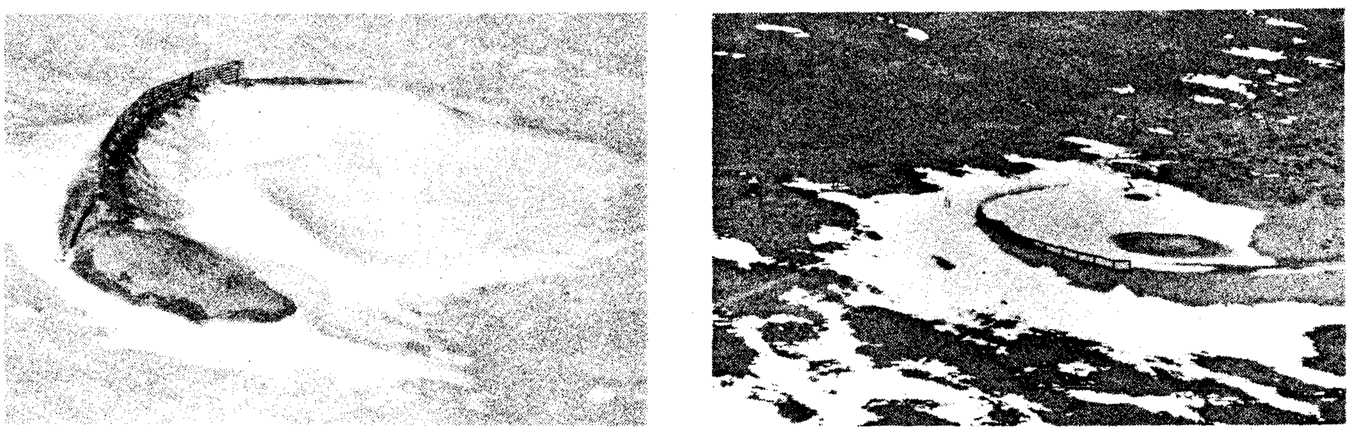

Figure 2. At three pit reservoirs like the one on the right, where the excavated fill had already been placed in a windward embankment, snow deposition increased after a 1.3-m-high (4 ft) snow fence was placed on the embankment, as the model on the left predicted. The model fence was scaled to a 2-m (6 ft) height. Much of the drifting snow is diverted around the pit, in both model and prototype.

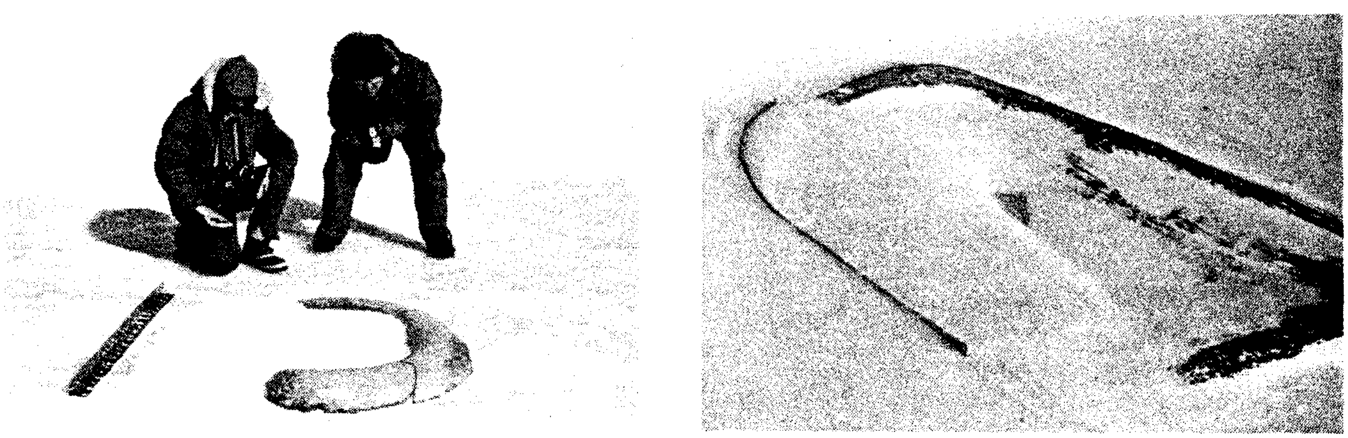

Figure 3. The model stock pond with downwind embankment and a snow fence on the windward edge of the pond produced the largest drift accumulation. Drifts that resulted at 9 pit reservoirs with similar combinations of snow fence and embankment support the conclusion that this arrangement works best. Prototype fence height (2 m) matches the model.

Tabler (1980b) demonstrated quantitative agreement of prototype drift depths with drifts on scaled models of complex terrain-snow fence systems. The visual agreement between full-scale drift patterns and modeling results (Figs. 1, 2, and 3) added to our confidence in predicting the full-scale volumes of snow and water expected in pit reservoirs. For each model, we combined snow depths measured along the model centerline (Fig. 4) and the known model dimensions (Fig. 5) to compute the values in Table 1. Dimensions in the figures are the full-scale values, assuming a scale of 1:30. Equivalent full-scale fence height for the 6.5-cm model was 2 m (6 ft). The 60-cm-diameter pit model was equivalent to a 18-m prototype with storage for 458 m^3 (121,000 gallons) of water. To convert measured volumes of snow deposited in the models into volumes of water predicted for prototypes, we assumed the snow would contain 40% water, an average value for the predicted drift depths (Tabler 1980a, p. 416).

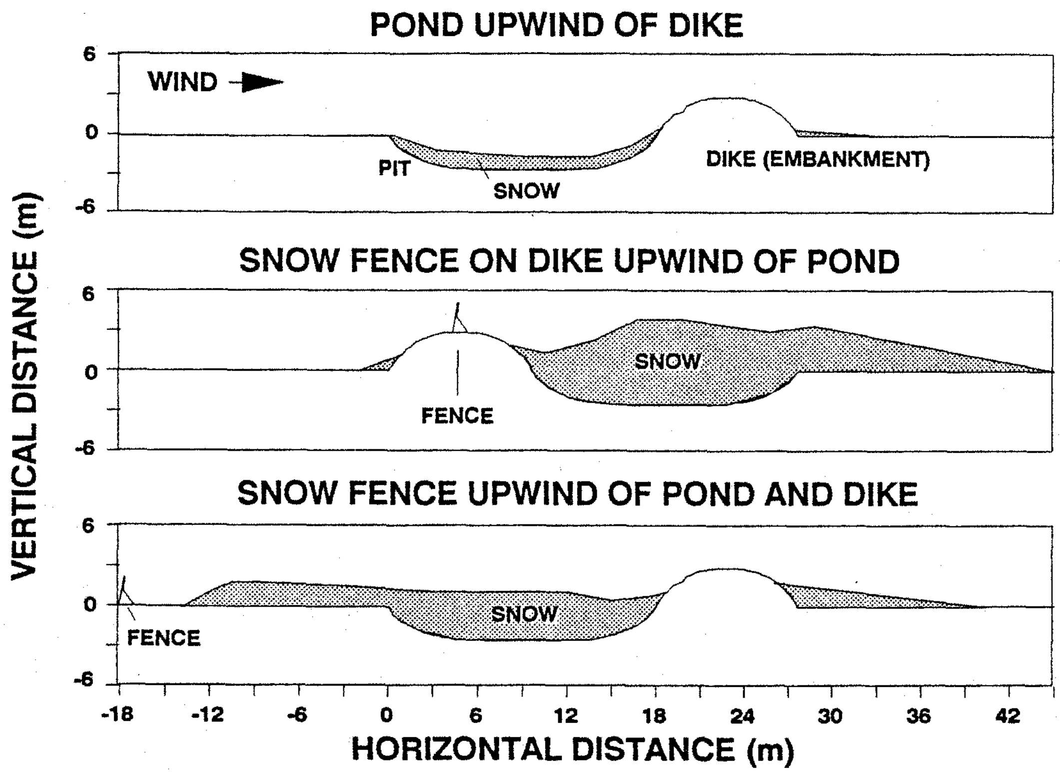

Figure 4. Cross sections through the center of each model showed deeper deposition in the model with a snow fence on the upwind embankment. However, this model collected drifting snow more slowly than the other models. The upwind embankment deflects much of the drifting snow away from the pit, resulting in lower trapping efficiency. Wind is from the left in the figure. The model scale is 1:30, and the dimensions shown are for the prototypes.

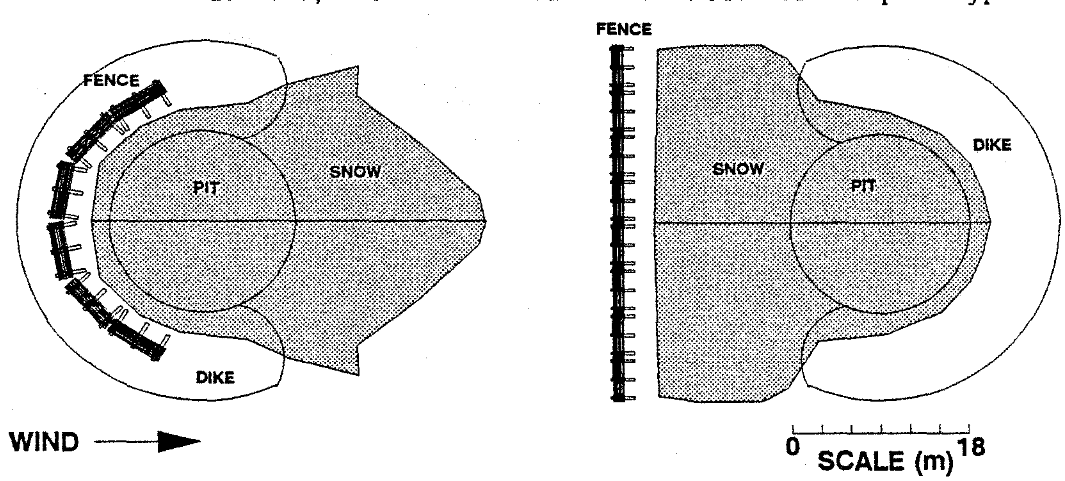

Figure 5. Plan views of the models in Figures 2 and 3 show the the extent of snow deposition around the 60-cm-diameter model pit. Grading must provide for drainage of melt water from surrounding drifts into full-scale pits.

Table 1. WATER VOLUMES PREDICTED FROM STOCK POND MODELS

MODEL[c]	MEASURED MODEL SNOW VOLUME TOTAL (cm^3)	MEASURED MODEL SNOW VOLUME ABOVE PIT[b] (cm^3)	PREDICTED FULL-SCALE WATER VOLUME[a] TOTAL (m^3)	TOTAL (gal.)	ABOVE PIT (m^3)	ABOVE PIT (gal.)
PD (Fig. 1)	9338	9338	101	26681	101	26681
FPD (Fig. 2)	54269	27148	586	154804	293	77402
DFP (Fig. 3)	52342	41342	565	149257	446	117820

[a]Assuming water volume is 40% of snow volume.
[b]Volume vertically above pit.
[c]PD=pit with downwind dike (embankment); FPD=snow fence upwind of pit with downwind dike; DFP=snow fence on dike upwind of pond.

Models shown in Figures 2 and 3 both predicted enough trapped snow to fill the pit reservoir with water (Table 1), assuming no leakage. However, in the model experiments, each test run continued until further deposition was negligible. Although drifting remained steady, the model with a snow fence on the embankment upwind of the pit (Fig. 2) took over twice as long to reach capacity, indicating a low trapping efficiency. Jairell and Tabler (1985) noted that much of the drifting snow was diverted around the pond by the upwind embankment. The drifts around the perimeter of the prototype embankment in Figure 2 suggest the same deflection. In years with below-normal drifting snow, such as 1989-90 on the Laramie plains in southeastern Wyoming, the arrangement in Figure 2 performs poorly.

CONCLUSIONS

Recommendations for snow fence and embankment locations at stock ponds, developed by Jairell and Tabler (1985) using small-scale modeling, were confirmed by observed full-scale results. Embankments should be downwind of pits, and a snow fence placed near the upwind edge of the pit maximizes drift snow catch. For pits with misplaced upwind embankments, a snow fence on the top of the embankment provides a worthwhile improvement in drift accumulation.

These results add support to the validity of small-scale outdoor modeling as a technique that provides quantitative estimates of snow deposition in geometrically complex situations.

REFERENCES

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