Value of Roofing Tower Silos and of Paper and Earth Covers for Trench Silos

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INTRODUCTION

After the program of pasture improvement and silo building was started by the Commonwealth Department of Agriculture and Commerce during the fiscal year 1953–54, a problem arose[2] as to the relative benefits of covering the chopped material in trench silos with paper and dirt, and of roofing tower silos. The question was, does the degree of top spoilage and the resulting quality of the silage make the cover and/or the roof necessary?

It was logical to assume that, if the amount of top spoilage and the quality of the resulting silage, as judged by the color, odor, and acceptance by the animals, were practically the same for covered and uncovered, and roofed and unroofed tower silos, there was no need of either. This would represent a saving to the farmers, more so in the case of big trench silos, which they first cover with paper and dirt, or dirt alone, later having to remove that cover in order to use the silage. Both operations represent considerable expense, even if mechanized.

It was thought also that, while the roof and the cover might be completely necessary to protect the silage against freezing, in the Temperate Zone, in Puerto Rico, where freezing does not occur, both might not be necessary.

LITERATURE REVIEW

Because extensive silo building and silage-making are relatively recent in Puerto Rico, there is no literature related to the problem here presented.

In the Temperate Zone, the literature relates to roofs and covers of the different types of silos, and refers to the different kinds and their effect on reducing top spoilage.

In New Zealand, Sears and Goodal (1),[3] comparing pit and stack silos, found that adequate consolidation of the top layers of stacks by means of an earth cap reduced losses appreciably, but provided no additional protection against rain.

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[2] The Pasture Specialist of the Extension Service, Elías Hernández, and E. Alverio from the Commonwealth Department of Agriculture met with the problem in the field and brought it to our consideration.

[3] Numbers in parentheses refer to Literature Cited, p. 82.

MATERIALS AND METHODS

TRENCH SILOS

A hole 30 feet long, 20 feet wide, and 10 feet deep was dug by a bulldozer. The trench was divided by wooden walls into six holes 10 x 10 feet. After being filled, three of the holes were covered with Sisalkraft paper and about 8 inches of dirt was placed on top. In the other three holes the content was left exposed. The ensiled material in all six holes was thoroughly trampled.

TOWER SILOS

The tower silos used were miniatures of 7.5 x 15 feet, each one holding around 10 tons of material. Three of these silos were left unroofed for this experiment. The material ensiled was thoroughly trampled as in the trench silo.

Merker grass mixed with some Pará and cane tops was used to fill the silos. The material was weighed in the trucks using lodometers. In the trench silos the weight of the material used for each hole was an average for the six. As the holes were equal in size the total ensiled was recorded and divided by six. For the tower silos the weight of the material ensiled was recorded individually.

PROCEDURE

Rainfall records were taken from the Station's weather station.

The silos were opened after 3 months and the spoiled material as well as the edible part were weighed carefully. Observations of quality were made based on general appearance, odor, and color. All the resulting silage was fed to the cows in the Station herd.

RESULTS AND DISCUSSION

The six holes into which the trench silo was divided received practically the same quantity of material per hole: 26,770 pounds, on the average. A comparison of the amounts of material put into the roofed and unroofed tower silos is as follows:

Silos	*Green material in pounds*	*Difference in pounds*	*Difference in percentage*
Without roof.....	14,183	976	7.39
With roof.....	13,207		

Table 1 presents the rainfall data for the period when the material was put into the silos until they were emptied.

The roof used was almost flat, permitting filling only up to a certain limit at which the men could work. In the unroofed silos the limit was the upper

TABLE 1.—*Monthly rainfall in inches for the period during which the material was in the experimental silos*

Month or period	Total for trench silos	Total for tower silos
Oct. 21–31, 1954	1.56	—
November	2.26	2.26
December	3.16	3.16
January 1955	1.75	1.75
February	2.48	2.49
Mar. 1–5	—	.63
Total	11.21	10.28

edge, permitting the placement of material that could very well be trampled up to that point. Silos with aluminum domes can be filled up to the upper border too. The fact that more material can be put into the unroofed than in the flat-top silos is an advantage also favoring the domed type.

A summary of the statistical analyses for the differences in the quantities of top spoilage in trench and tower silos is given herewith:

Item	*Average spoiled material Pounds*	
Tower silos:		
Without roof		2,502
With roof		2,325
Difference		177
L.S.D. for 5-percent level	940	
L.S.D. for 1-percent level	1,559	
Mean difference not significant.		
Trench silos:		
Uncovered		3,098
Covered		2,226
Difference		872
L.S.D. for 5-percent level	502	
L.S.D. for 1-percent level	833	
Mean difference highly significant.		

The roof had no influence in lessening the quantity of top spoilage in the tower silos used in the experiment reported here. Apparently the roof is unnecessary if the only thing desired is to reduce top spoilage.

Unloading equipment can be installed on silos with or without a roof, but a roof will protect the equipment. Domed roofs, besides protecting the equipment, will also permit the filling and trampling of the material up to the upper edge of the silo, which is an advantage over the flat-tops.

In trench silos the difference between the quantities of top spoilage in the covered and uncovered holes was highly significant. This indicates that protection of the material, together with the pressure exerted by the weight

of the dirt put on top, is necessary to reduce top spoilage in this kind of silo where so much surface is exposed in addition to the corners where more spoilage always occurs.

Rainfall was not excessive (see table 1) since the average for the northern coastal plains is around 60 inches a year (2). Total precipitation during the conservation period is a factor that should be taken into consideration in relation to the cover of trench silos because of the surface exposed.

The normal rainfall in the northern section of the Island will probably not harm the material in the open tower silos, especially when provided with good drainage; that is, it will not increase top spoilage. In the south and southwest, where the average rainfall is around 30 inches (2) a year, this is a matter of even less concern. It was mentioned in the Literature Review that the protection of stack silos against rainfall produced no beneficial effects in the work of Sears and Goodal in New Zealand. This was probably because of the good drainage in this type of silos.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

In its silo-building campaign the Department of Agriculture and Commerce and the Agricultural Extension Service fieldmen have often been asked to make recommendations about the relative benefits of the roof in tower silos and the use of cover in trench silos. The problem arose when a local firm began constructing roofless silos, and the cost of covering the material in big trench silos began to be considered, as well as the removal of that cover when the silage was to be used.

An experiment was conducted to determine whether it was necessary to cover the trench silos, and whether the roof was necessary in tower silos, judging from the extent of top spoilage and the general quality of the edible portion. The findings apply, of course, under Puerto Rican conditions.

Covering is necessary for trench silos. So much surface is exposed that the resulting top spoilage is very large if the contents are not protected.

According to the results obtained in this experiment a roof is not necessary for tower silos; no better quality silage and no less top spoilage were obtained by its use. If unloading equipment is to be used, though, a roof will protect such equipment.

Another fact to be considered is the following: It was found in the work reported here that the absence of a roof permitted filling the silo up to the edges, and also a more thorough trampling of the material. The same results can be obtained with domed roofs. Flat roofs will not permit a thorough trampling of the material up to the edges because men cannot work inside the silo at that level.

RESUMEN, CONCLUSIONES, Y RECOMENDACIONES

Durante la campaña para la construcción de silos, los agentes de campo del Departamento de Agricultura y Comercio y del Servicio de Extensión

Agrícola se enfrentaron con el problema de tener que hacer recomendaciones en cuanto a los beneficios relativos del techado de los silos de torre y el uso de cubiertas para los de trinchera. El problema surgió cuando una firma local empezó a construir silos de torre, sin techo, y cuando se pensó en el costo de cubrir los silos grandes de trinchera con el consiguiente trabajo que significaría remover esa cubierta al empezar a usar el ensilaje.

Para dilucidar este problema, se llevó a cabo un experimento cuyo objetivo fué determinar si era necesario cubrir los silos de trinchera y si se hacía indispensable el techo en los silos de torre, tomando en consideración la cantidad de ensilaje que se dañara en su parte superior y la calidad del resto del ensilaje usable.

Se determinó que es necesario cubrir los silos de trinchera. Es tanta la superficie que se expone a la intemperie en estos silos que la cantidad de ensilaje que se deteriora resulta muy grande.

De los resultados de este experimento, también se determinó que los silos de torre no necesitan techo porque no se obtuvo mejor calidad de ensilaje ni se aminoraron las pérdidas de ensilaje en su parte superior con su uso. No obstante, si se va a usar equipo para disponer del ensilaje el techo protegería el mismo.

Otra ventaja que se observó en el experimento, en cuanto a la ausencia de techo en los silos de torre, fué que bajo estas condiciones se puede llenar el silo hasta sus bordes, permitiendo apisonar bien el material. Los mismos resultados se obtienen usando techos del tipo dómico. Los techos planos no permiten llenar el silo hasta los bordes porque esto hace imposible, a ese nivel, que los obreros puedan apisonar bien el material dentro del silo.

LITERATURE CITED

1. Sears, P. D., and Goodal, V. C., A comparison of losses in pasture silage made in pots and stacks under various conditions, *New Zealand J. Sci. and Tech.* **28A** (5) 289-304, 1947.
2. Koenig, Nathan, A comprehensive agricultural program for Puerto Rico, U.S.D.A. Wash., D. C., In cooperation with the Commonwealth of Puerto Rico, U. S. Government Printing Office, 1953.