Hoop Structure Bedding Use, Labor, Bedding Pack Temperature, Manure Nutrient Content, and Nitrogen Leaching Potential

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Summary and Implications

Central Iowa hoop structures used for finishing pigs were closely monitored. Bedding use was 124 lb to 262 lb per pig for the finishing period. More bedding was used in winter than in summer. The bedding was primarily large round bales of cornstalks. Labor requirements varied from .3 to .6 hours/pig depending on total bedding use and experience of the manager. The bedding/manure pack was sampled at nine locations. Pack temperatures ranged from 30ºF to 113ºF 6 inches below the surface during February. Moisture content varied from 23 to 75% moisture. Nitrogen (N), phosphorus (P), and potassium (K) values also were variable. Soil samples under the pack indicated increased soil nitrogen as nitrate. More research is needed in all of these areas.

Introduction

Hoop structures are a low-cost alternative pig housing system that is gaining attention in the upper Midwest. Hoop structures use treated wood posts and tongue-in-groove siding for approximately 6-ft side walls. Steel tubes or trusses are fastened to the top of the side walls to form an arch. The arch is covered with a UV-resistant polypropylene tarp. An earthen floor that is heavily bedded is used in the majority of the structures. The remaining floor area is designated as the feeding and watering area and is covered with concrete about 15 ft to 20 ft of the south end.

Materials and Methods

Description of facility and management. The hoop structure used for the Iowa State University study was erected in 1993 at the ISU Rhodes Research and Demonstration Farm. The structure is 30 ft by 60 ft and was donated by AmCan, Inc[1]., Bloomington, IL. Finishing pigs are placed in this structure at approximately 60 lb at a stocking density of 12 sq ft per pig. The hoop is oriented southeast/northwest, although the recommended orientation is north/south to catch the predominant summer winds. The structure has 6-ft side walls. The southern end has 18 ft of concrete on which feeders are placed. Nipple waterers are also in this area with a slight slope to the outside in case of a waterline break.

During the winter the north end remains closed during most of the winter while the south end remains open. Ventilation air enters the facility through spaces between the side wall and the tarp. This air mixes in the structure. Warm, moist air moves up toward the top of the arching hoop and is carried by natural air currents through the south end.

Bedding in most hoop structures in Iowa is done with cornstalks. However, wheat straw, bean stalks, wood shavings, and paper have been used with some degree of success. Hoops are not a warm environment in winter and, therefore, need to be heavily bedded to absorb wetness and provide a way for pigs to modify their effective environment.

For the nitrogen leaching sampling, a hoop site was sampled, on a private farm in Story County. All hoops were erected on packed soil with a high clay content. Two soil samples were taken outside the hoop as a baseline measure. After one group of pigs was marketed, two soil samples were taken inside the hoop. Later, after the second group was marketed, two more samples were taken. Soil samples were taken at 5–1 foot depth increments.

Bedding and labor. During these experimental trials the goal was to bed heavy enough to absorb all the liquid during the winter trials. For winter trials, generally five large cornstalk bales (approximately 1,100 lb each) were placed in the hoop at the beginning. Later, two bales were added weekly, as needed. Bedding data are shown in Table 1. Considerably less bedding was used during the summer. During Winter 2, (96–97) less bedding was used than in the Winter 1 (95–96) for two reasons. First, temperatures were not as cold during Winter 2 as Winter 1. Second, a shortage of bedding prompted the farm crew to bed more conservatively. The Winter 2 pigs had a

[1] Mention of company or product names is for presentation clarity and does not imply endorsement by the authors or Iowa State University, nor exclusion of any other products that also may be suitable for application.

poorer feed efficiency that may be partly due to a shorter bedding supply.

The amount of labor is related to the amount of bedding. Most of the labor is used for bedding, checking animals, hauling manure, and sorting/loading animals. Some of the decrease in labor during Winter 2 is probably due to the farm personnel learning how to manage the system more efficiently and also due to less bedding being used. Labor is a hotly debated issue, with some producers saying less labor is spent using hoop production whereas others state the opposite. Labor per finishing pig is a highly variable input depending on many factors, e. g., farm size, level of automation, etc. Based on the three trials conducted, finishing pigs in hoops seems to require a reasonable and competitive amount of labor per pig.

Because this system uses a deep-bedded pack, some incidental composting occurs during a production cycle. This helps to break down the bedding and provides some heat for the pigs. Although this is a source of some heat, it varies greatly with location. Figure 1 illustrates the measurement sites in the bedding pack and Table 2 gives the temperatures at different depths. Table 3 gives nutrient content at these same locations. Manure from hoop structures is highly variable in nutrient content depending on the dunging locations. The variation of average bedded pack temperature, water, and nitrogen content also are illustrated in Figures 2–4, respectively. Manure from hoop structures is highly variable depending on the dunging locations. The wet dunging area has most of the nutrients, whereas the drier areas of bedding achieve higher temperatures. Under winter conditions this situation is optimal for the pigs, with added warmth from the decomposing bedding in the areas where they spend most of their time. However, during summer this additional heat is unwelcome, and the pigs move to other areas of the bedding pack.

Bedding cleanout and manure handling. The bedding from hoop structures is normally cleaned out after each group of pigs is sold, i.e., two to three times a year. At that time the manure/bedding mixture is either directly spread on fields or stored for later use. Because this is solid manure handling, storage requirements are minimal, although there may be some concern about nitrogen leaching from storage especially during high rainfall periods. The average characteristics of the manure/bedding mixture are ideal for composting, which provides volume reduction and nutrient stabilization prior to field application. Such composting will occur with minimal management if the material is piled in windrows about 6 ft high and 12 ft wide.

As it comes directly out of the hoop structure, the high degree of variability in the bedded pack makes it difficult to predict manure nutrient contributions to crop fertilization needs. Although manure from the dunging area has clear fertilizer value, the high-carbon/low-nitrogen status of the drier bedding may lead to nitrogen immobilization and crop stress if applied during or immediately prior to the growing season. Mixing the material to achieve a higher degree of uniformity would improve this situation, and such mixing currently occurs to some degree if the bedded pack is piled for storage or composting prior to field application. Additional mixing, such as would occur during turned windrow composting, appears likely to offer a considerable benefit. Trials to examine the effect of storage, mixing, and composting on manure nutrient levels and uniformity are planned for the coming year.

Nitrogen leaching. The nitrogen concentrations (as parts per million as nitrate, ppm $N\text{-}NO_3$) of the soil under the bedding pack inside a hoop are shown. The soil samples are very low ($\leq$1 ppm $N\text{-}NO_3$) at all depths (Table 4). After one group of pigs, the surface (0–1 ft depth) nitrogen increased to 5.5 but other values changed little. After two groups, nitrogen values at all levels increased approximately three times. Nitrogen as nitrate is the soluble form of nitrogen and there may be other pools of ammonium or nitrogen from pig urine in soil. These results suggest a need for more detailed research on this topic. Hoops may be a potential source of soil nitrogen leaching.

Further information. Further detailed information, including management tips and cost estimates, may be found in *Hoop Structures for Grow-Finish Swine*. This is MidWest Plan Service publication AED-41. Copies may be obtained from MidWest Plan Service by calling 1-800-562-3618 or ordering it from Extension Publications Distribution, 119 Kooser Dr., Iowa State University, Ames, IA 50011-3171.

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Table 1. Bedding and labor used for the hoop structure trials.

	Winter 1 (95–96)	Summer (96)	Winter 2 (96–97)
Bedding (large bales)	cornstalks	cornstalks	2/3 cornstalks, 1/3 oat straw
Total Bedding (lb)	39,600	18,600	31,500
Bedding/pig	262	124	193
Manure Removed (tons)	100	36	74
Total labor (hr)	90	62	51
Labor/pig	0.61	0.42	0.32

Table 2. Bedding temperature by site and location (degrees F).

Site	Temp. at 6 in. from surface	Temp. at 12 in. from surface	Temp. at 18 in. from surface
W 1	30	30	30
W 2	44	59	59
W 3	58	67	70
C 1	80	81	78
C 2	113	117	–
C 3	102	114	100
E 1	75	74	74
E 2	86	88	84
E 3	78	75	67

Table 3. Bedding nutrients by location.

Site	Total moisture (%)	Total nitrogen (lb/ton)	Phosphorus (lb/ton)	Potassium (lb/ton)
W1	73.7	20	21	12
W2	75.2	22	22	12
W3	68.5	22	31	16
C1	67.4	14	20	26
C2	22.9	11	21	37
C3	27.6	22	17	26
E1	68.5	29	24	29
E2	30.6	36	40	51
E3	73.5	16	13	15

Table 4. Nitrogen concentration in soil at various depths in hoop structures.

Soil sample depth (ft)	Outside ppm $N\text{-}NO_3$	After one group ppm $N\text{-}NO_3$	After two groups ppm $N\text{-}NO_3$
0–1	1	5.5	14.5
1 to 2	1	1.5	3.0
2 to 3	1	1.0	3.5
3 to 4	1	1.5	3.5
4 to 5	1	1.0	3.0

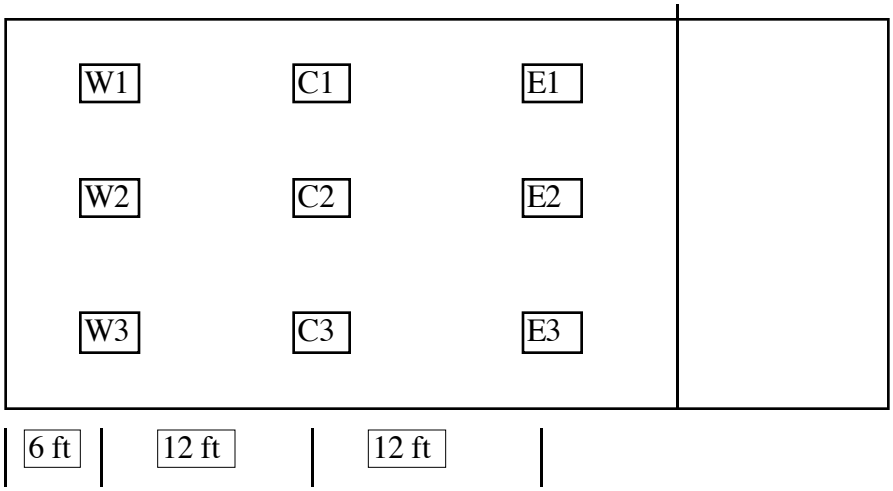

Figure 1. Measurement sites of bedding traits. The right end is the concrete feeding area.

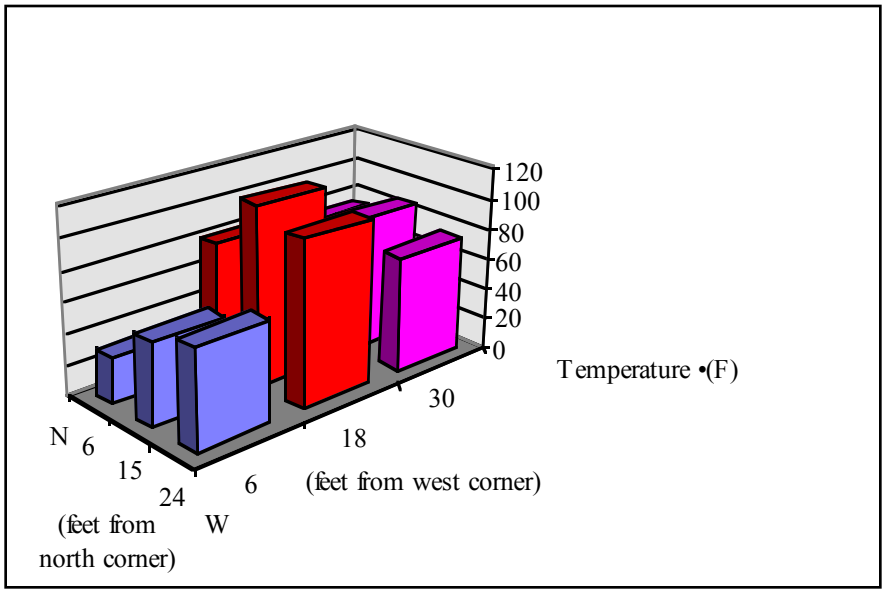

Figure 2. Average temperatures at various locations in the bedded pack of a hoop structure (Rhodes Farm, 2/27/97).

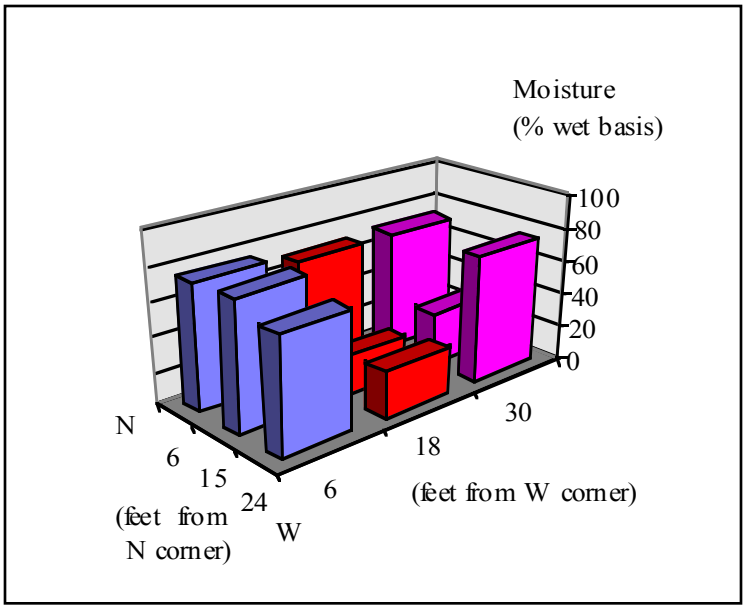

Figure 3. Moisture variation in the bedded pack of a hoop structure (Rhodes Farm, 2/27/97).

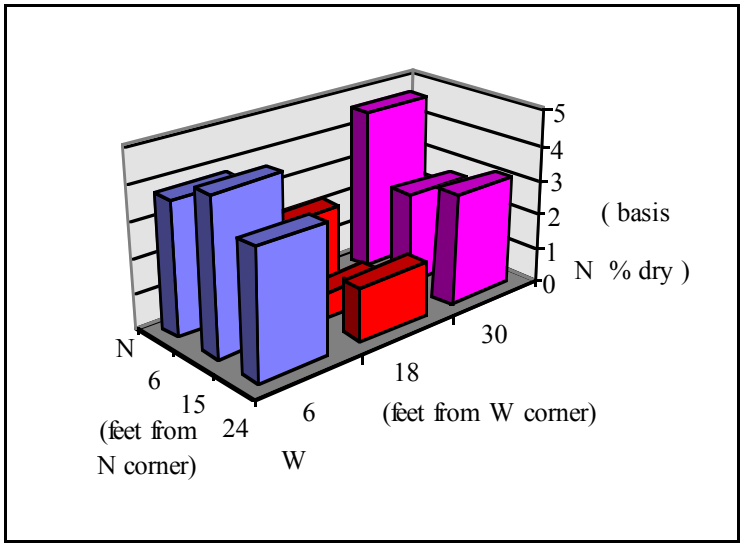

Figure 4. Nitrogen variation in the bedded pack of a hoop structure (Rhodes Farm, 2/27/97).