

# SLURRY UTILIZATION SYSTEM IN THE PADDY FIELD

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## ABSTRACT

To improve the uniformity of slurry spreading and to reduce the odor problem, a hose slurry spreader was developed, which spread the slurry near to the surface of the soil. First, the uniformity of slurry spreading was investigated. The best result of 8.1% CV was obtained at the rotor speed of 250 rpm than any other speeds for the swine slurry, which contains 13.6% of dry matter. In case of dairy cattle slurry, which contains 8.2% of dry matter, the uniformity has the best result of CV 7.2% by high rotor speed of 330 rpm. A high speed of rotor has built a sufficient pressure in the distributor and discharged a uniform quantity of slurry through the hoses. Therefore, in practical use one should work with rotor speed over 300 rpm to maximize the uniformity of slurry spreading. Second, odor test was done with the swine slurry. While the conventional spreader shows  $\Sigma$  value 440, the hose slurry spreader and its combination of disk harrow show  $\Sigma$  value 258 and 184 respectively. With the air dilution sensual test and a 3-point odor bag, the conventional spreader shows 66.9 or 35.4 point and by the hose slurry spreader is 9.7 or 11.1 point. So, the developed spreader was found to have a greater effect on the reduction of odor problem. Finally, it is recommended to spread certain amount of the slurry for paddy field equivalent to the chemical fertilizer based on the N-content. It means 22 tons of swine slurry per ha. Since most of the livestock farms possess less arable land, a system of linking farms is necessary to utilize the slurry crossover the farms. The cost of slurry utilization including filling, transport spreading and brokerage is 3200~6800 Won/m<sup>3</sup> in accordance with the transport distance.

Key Words : Hose slurry spreader, Spread uniformity, Odor, Utilization

## INTRODUCTION

The livestock manure contains the fertilizer components, which can be utilized by plants. Therefore, it is an economical and environmentally friendly method to recycle the livestock manure in the land as an organic fertilizer. Especially, the slurry might be useful for the paddy field, which is over 60% of the arable land in Korea, but the utilization is not widely extended. In using the slurry, there are some problems to be solved such as available land, uniform spread and odor control. The maximum amount of harvest without environmental pollution could be expected in case of applying uniform amount of slurry. The amount of spread slurry can influence the growth of plant. For example, it is reported that the deviation of spread quantity  $\pm 35\%$  can cause harvest loss of 5~12% by grains and 3~10% by corn (Kowalewsky and Vetter 1982).

The working principle of conventional slurry spreader is based on the coalition or pressure method so that the deviation is significant. The spread amount is relatively large in the middle part compared to the border. It could be affected by the wind and cause odor problem. Therefore, to insure the spread uniformity and to reduce odor problem, a hose slurry spreader is developed, which enables to spread the slurry near to the surface of the soil. The spread uniformity and the reducing effect of odor are analyzed in the test.

## MATERIALS AND METHODS

The hose slurry spreader is consisted of a central distributor, a hydraulic motor, a hydraulic cylinder, a frame, several hoses and their attachments. The central distributor is consisted of a housing, a rotor and a hydraulic motor. The rotor is rotated by the hydraulic motor, which gets the power from the hydraulic pressure of tractor.

To measure the spread uniformity, equipment is constructed. The amount of spread slurry depends on the rotor speed. To control the rotor speed, an electric motor or a hydraulic of tractor is used. The measurement equipment has 20 cylinders to receive the slurry through 20 hoses and it can be moved by means of the chain. The slurry is recycled in this system. A screw pump charges the slurry from the storage tank to the central distributor and then the slurry is gathered in the cylinder at a certain time. After measuring the quantity, it is returned to the storage tank. As a test material for the uniformity of spread slurry, the dairy cattle slurry and the swine slurry were taken. The rotor in the central distributor is controlled by 3 steps such as low, middle and high speed. To measure the rotation speed, a contact tachometer was used. The test was done in 3 repetition and

the coefficient of variation (CV) was calculated.

For the odor measurements, two kinds of sensual tests such as air dilution sensual test and 3-point odor bag method were used. Also, the odor is measured by the odor tester (Kalmor- $\Sigma$ ) and the results were compared. The following table shows the criterion and the practical meaning.

$\Sigma$ Value	Practical meaning	Evaluation
0~180	Fresh air without odor	⊙
180~220	No smells by normal person	○
220~250	Some odor, need no ventilation	△
250~350	Feel enough odor, torment	▲
Over 350	Unpleasant	■

## RESULTS AND DISCUSSION

The swine slurry has dry matter content from 13.6%, which is more than the practical one, because it contains a large amount of settle layer pumped from the storage tank. The uniformity with the swine slurry shows CV of 12.9%, 14.4% and 8.1% as increasing the rotor speed from low to high. The results are shown in the figures 1, 2, 3 and table 1. The dairy cattle slurry has its dry matter content from 8.2% and the spread uniformity shows the best result as CV 7.2% by high rotor speed from 330 rpm. Because of the dry matter, some pressure is needed by the high rotation speed. It is required the variation under  $\pm 10\%$  by spreading the chemical fertilizer. In case of slurry, it is acceptable when the variation is under  $\pm 15\%$  (Vetter and Steffens 1986). While the conventional spreader shows the variation range of 25~27%, the developed hose slurry spreader shows CV of 7~8% by 300 rpm of rotor. In this spread system, the capacity of pump and distributor should be suitable each other so that a sufficient pressure should be built in the central distributor.

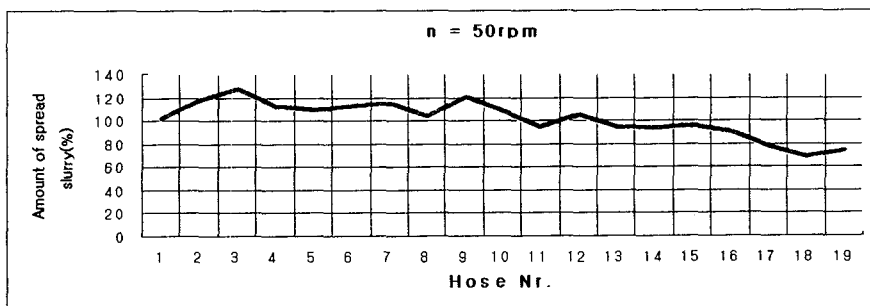


Fig. 1. Spread uniformity of swine slurry (Rotor speed 50rpm)

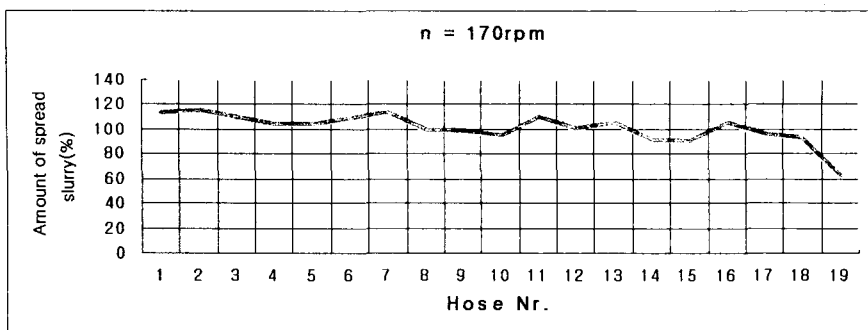


Fig. 2. Spread uniformity of swine slurry (Rotor speed 170rpm)

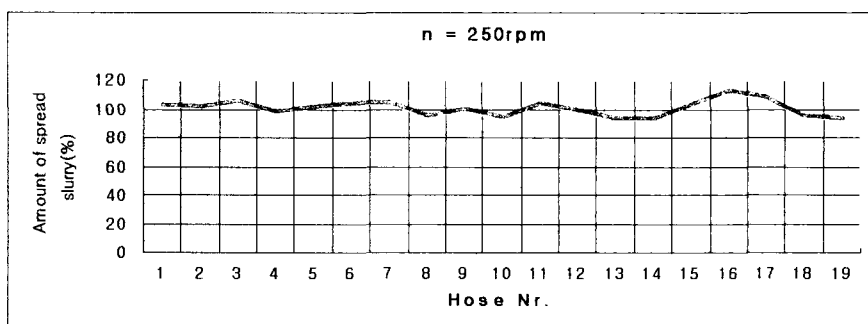


Fig. 3. Spread uniformity of swine slurry (Rotor speed 250rpm)

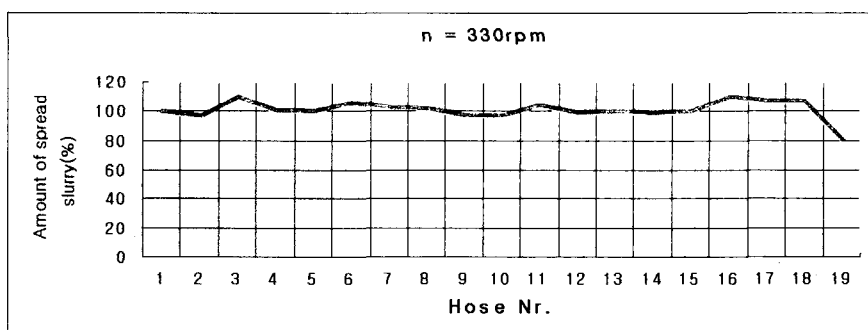


Fig. 4. Spread uniformity of dairy cattle slurry (Rotor speed 330rpm)

Table 1. CV with rotor speed in different materials

Material	Rotor speed(rpm)	CV(%)
Swine slurry	50	12.9
	170	14.4
	250	8.1
Dairy cattle slurry	330	7.2

By the odor tester for swine slurry, it has shown  $\Sigma$  value 440 with the conventional spreader. It was  $\Sigma$  value 258 with the hose slurry spreader and  $\Sigma$  value 184 with the combination of disk harrow, which enables to cover the slurry with the soil. Average value 440 with a conventional spreader provides a situation that man feels unpleasant and average value 258 with a hose spreader provides a situation that man feels some odor. However, a normal person can not smell in cases of value 184. The effect of reducing odor is obvious. With the air dilution sensual test and a 3-point odor bag, the conventional spreader showed 66.9 or 35.4 point and by the hose slurry spreader was 9.7 or 11.1 point. In this case, the developed spreader has also a greater effect in reducing odor than the conventional spreader.

Table 2. Degree of odor (swine slurry, dry matter 4.0%)

Conventional spreader	Maximum	687
	Minimum	194
	Average	440
Hose spreader	Maximum	332
	Minimum	185
	Average	258
Hose spreader Disk harrow	Maximum	246
	Minimum	123
	Average	184

( Outside air : Standard 100 )

Table 3. Result by two sensual tests

	Air dilution sensual test	3 point odor bag
Conventional spreader	66.94	35.44
Hose spreader	9.65	11.16
Hose spreader + Disk harrow	9.65	11.01

The slurry spreading system can be divided in 3 categories according to the distance. System 1 is suitable for a short distance between livestock farm and spread land. The slurry spreader transports the slurry within this distance. System 2 is suitable for a long distance between livestock farm and the land. Therefore, it is recommended to use an intermediate tank in the field to increase a working performance. A truck with a tank transports the slurry between the storage and intermediate tank. From the intermediate tank to the land, a slurry spreader or hose linked spreader is used. System 3 can save the labor, because it works automatically. However, it should

be used for the place far from the residence area because of the odor problem.

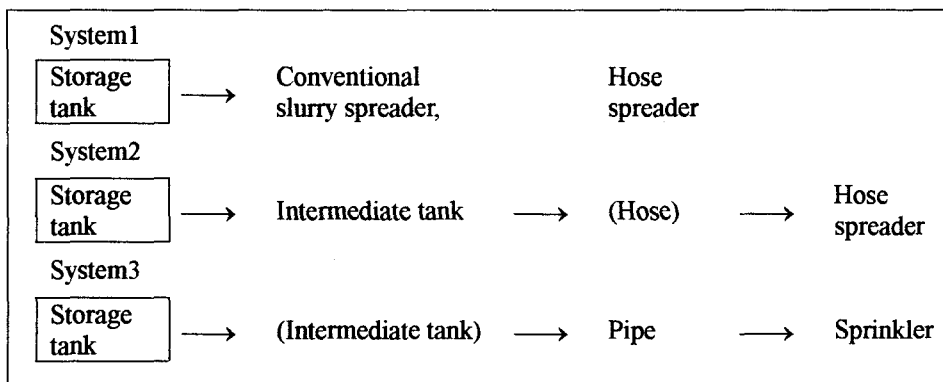


Fig. 5. Types of slurry spread system

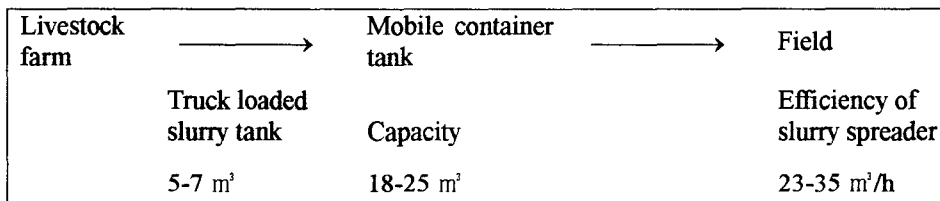


Fig. 6. System for the using mobile container tank.

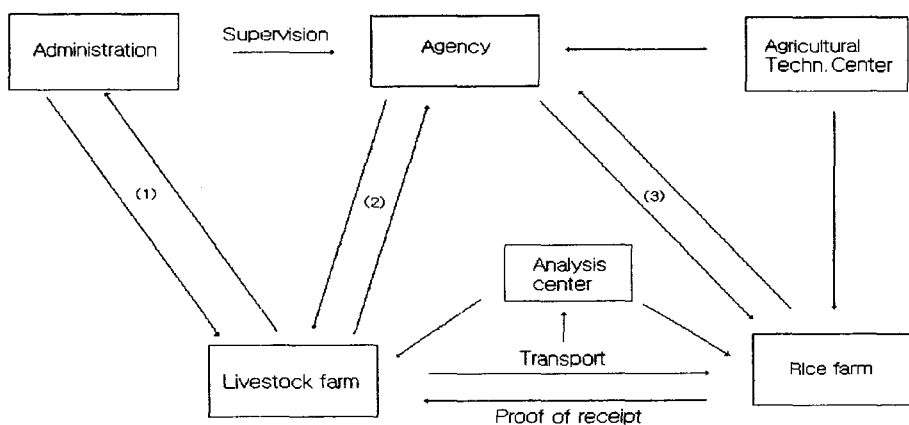
It is recommended to spread certain amount of the slurry for paddy field equivalent to the chemical fertilizer based on the N-content. As the amount of spread slurry is increased or spreading time is close to the rice transplanting, NO<sub>3</sub>-N content in the settling water is increased. The spread amount of slurry is confined considering amount of NO<sub>3</sub>-N flow out. When the slurry is used immediately after harvest, the optimal amount of spread slurry is expected as 150% of nitrogen quantity based on the chemical fertilizer. When it is spread on April or May direct before transplanting, the optimal amount of slurry is 100% of nitrogen, which is equivalent to 22 tons of swine slurry per ha.

Because most of the livestock farms possess less arable land, a system of linking farms is necessary to utilize the slurry crossover the farms. The total cost including filling, transport, spreading and brokerage is 3200~6800 won/m<sup>3</sup> according to the distance.

Table 4. Grain yield of rice using the slurry by different seasons

Treatment	Spikelet Nr./Head	% matured grain	1000-grain weight (g)	Grain yield (kg/10a)	Index
Control	95	93.5	29.7	671	100
<b>Spreading time</b>					
<b>Fall</b>					
Slurry 100%	91	95.6	30.8	583	87
Slurry 150%	94	96.0	29.4	666	99
Slurry 200%	96	93.9	29.3	671	100
<b>April</b>					
Slurry 100%	95	89.2	27.9	665	99
Slurry 150%	91	88.8	28.9	705	105
Slurry 200%	115	85.7	27.9	651	97
<b>May</b>					
Slurry 100%	90	95.2	30.1	661	98
Slurry 150%	104	93.3	29.0	683	102
Slurry 200%	115	86.2	28.0	640	95

(National Agricultural Science & Technology Institute, RDA, 1999)



- (1) Livestock farm gets a permit from the administration for slurry utilization.
- (2) Livestock farm gives a notice to the agency, which informs the demander of slurry to it.
- (3) Rice farm reports his land size and receives the slurry.

Fig. 7. Organization of slurry utilization

## CONCLUSIONS

A hose slurry spreader is developed, which spreads the slurry near to the soil surface. The uniformity of slurry spreading is investigated. In swine slurry, which contains 13.6% dry matter, it has shown the best result of 8.1% CV by 250 rpm of high rotor speed than low or middle speed. In case of dairy cattle slurry, which contains 8.2% of dry matter, the uniformity showed the best result of CV 7.2% by high rotor speed of 330 rpm. Odor test is done with the swine slurry. While the conventional spreader shows  $\Sigma$  value 440, the hose slurry spreader and its combination of disk harrow show  $\Sigma$  value 258 and 184 respectively. With the air dilution sensual test and a 3-point odor bag, the conventional spreader shows 66.9 or 35.4 point and by the hose slurry spreader is 9.7 or 11.1 point. The spread amount of slurry is confined considering amount of  $\text{NO}_3\text{-N}$  flow out. When the slurry is used immediately after harvest, the optimal amount of spread slurry is expected as 150% of nitrogen quantity based on the chemical fertilizer. When it is spread on April or May direct before transplanting, the optimal amount of slurry is 100% of nitrogen, which is equivalent to 22 tons of swine slurry per ha. Because most of the livestock farms possess less arable land, a system of linking farms is necessary to utilize the slurry crossover the farms. The total cost including filling, transport, spreading and brokerage is 3200~6800 won/m<sup>3</sup> according to the distance.

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