

## **A Development of Composting System**

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### ***Summary***

A simple compost windrow-forming car and a compost tuner were developed at the aim of low cost manure management systems. The developed compost windrow-forming car is possible windrows formation at a short time. In order to be pulverized and mixed by upper and lower beaters at the windrow-forming, the condition of air and the mixing of materials to play a major role in composting is filled. This car can also utilized for a manure spreader by folding the windrow-forming cover. The developed compost turner is a type equipped with tractor rear-right side. Main specifications are 2.5m working width, overall length 3.3m and 45 degrees conveyer inclination angle. 2 beaters for mixing and pulverization are equipped in front parts. Windrows of 2.5m width and 1.5m height are turned at the speed of 4.5-5.1m/min.

In accordance with the above, by combining the compost windrow-forming car and the compost turner, a simple composting system for each farmer could be constructed by the low cost.

## ***1. Introduction***

With magnification of a livestock scale and specializing or regional omnipresence, the quantity of manure per an administrative unit is enlarging. On the other hand, the connection of a daily farmer and other agricultural systems fades and this fact has begun to be caused the contradiction with a natural environment. While the importance of environmental protection rises, a sign of the environmental pollution which dairy farming has taken as a cause is conspicuous by a form such as pollution of a water system and odors. Manpower insufficiency also spends a spur on this, and the voice which "cannot but reduce the number of animals to the limit which can manage manure" is also heard. From the viewpoint of environmental protection and dairy management, the development of the manure management system which is premised on cheap, simplicity and material circulation is the most important problems.

In this report, the development of the compost windrow-forming car and the compost turner which is premised on an introduction to each farmer is reported.

## ***2. The development of the compost windrow-forming car***

In order to manage manure with an efficient small area, it is important to pile on a fixed form. The effect of landscape improvement and the dissolution of a filth feeling can be expected and it is also effective in handling after composting.

Then, the windrow-forming car to pile a fixed form in a short time was developed. This machine used to remodel the manure spreader which is widely used. The points of reconstruction are a floor conveyer speed for unloading and the cover of spreading part. The conveyer speed is changed a high speed about 10 times at the time of manure spreading and to prevent a scattering of manure and to regulate the windrow shape, a removable cover was equipped to manure discharging parts. 2 machines of maximum carrying capacity  $1.5\text{m}^3$  and  $8\text{m}^3$  were developed. Forming of windrow was respectively possible in a short time with  $20\text{s}/1.5\text{m}^3$ ,  $52\text{s}/8.0\text{m}^3$ . A cross-section of windrows is respectively a roughly semicircular of diameter 2.4m, 3.7m.

Speaking for the function of this machine, as manure materials are pulverized and mixed by upper and lower beaters at windrow-forming, necessary conditions for composting such as the mixing of air and the uniform mixture of materials are filled. When manure

materials have been piled by a bucket loader and so on, if a compost turner is about to be used, we have to divide the middle of windrows and big power is needed on this. If manure materials are piled in windrows orderly, in order not to need power for dividing the middle of windrows turning work is easy. Moreover, this machine can also be utilized for a manure spreader by folding the windrow-forming cover and changing a speed of a floor conveyer. Since this car has the functions of the spreading which they have formerly and the windrow-forming, it is advantageous economy. In addition, it is also effective in utilization within the composting storage or a simple composting house that the mobility of a loader etc. is limited and enough work is not possible. Since it can be piled by going straight on as it is, if the composting storage is frontage 6m, 2 windrows can be formed with space for vehicle traffic of about 2m between windrows.

Windrow-turning is indispensable for composting and this machine is also premised on the introduction of a compost turner.

### ***3. Compost turner***

In composting process the appropriate moisture content and the appropriate air condition are essential. Manure is piled in the condition of pulverization and uniform mixture by this machine. But the worsening of aerobic respiration advance with time, and the appropriate ventilation for composting are prevented. Moreover, unevenness microbial activity has been also caused. Then, the improvement of aerobic conditions by mixing and turning is needed. For this reason a compost turner is necessary.

The developed compost turner is equipped to a tractor rear-side, and this turner has equipped 2 beaters for pulverization and raking and a conveyer for discharge. Compost materials are raked in by 2 beaters and are conveyed rearward by the conveyer. These materials on the conveyer are discharged from the conveyer edge of height 2m. By forming windrows in the condition that was mixed and pulverized sufficiently by beaters and the conveyer, the promotion of composting can be expected. This machine is designed for a compact. Dimensions are 3.31m total length, 2.5m total width, 2.02m total height and 1500kg total mass. The equipment to tractors is easily and it can be installed in the rear of tractors at the time of movement. Working speeds are about 4.5~5.1m/min for the windrows of 2.3m width, 1.2m height. Required power is about 30kW. It has contributed to the decrease of required power that it is already pulverized at the time of

the windrows forming. Drawbar power is a little under 1kW in a drying road surface.

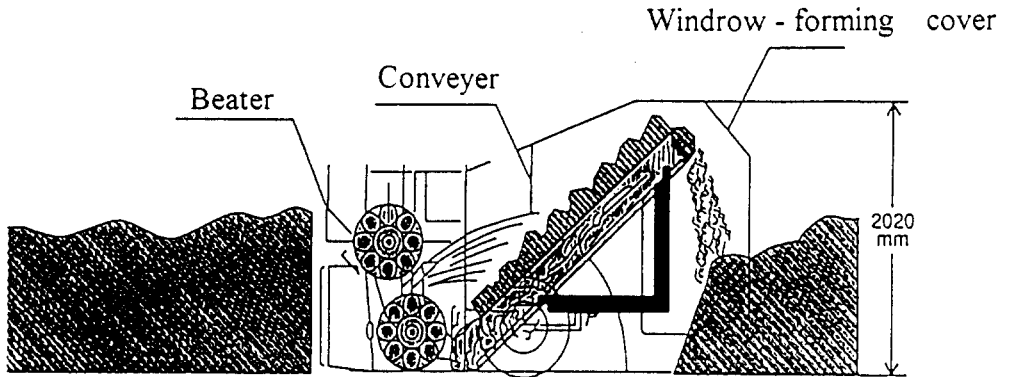


Figure 1. Mechanism of Turner

#### 4. Actual test

The composting pad using the materials for soil hardness was constructed and a systematic composting test was carried out by the combination of the windrow-forming car and the compost turner in open-air. An experimental ward was 2 management of moisture regulation materials existence using cattle raw materials.

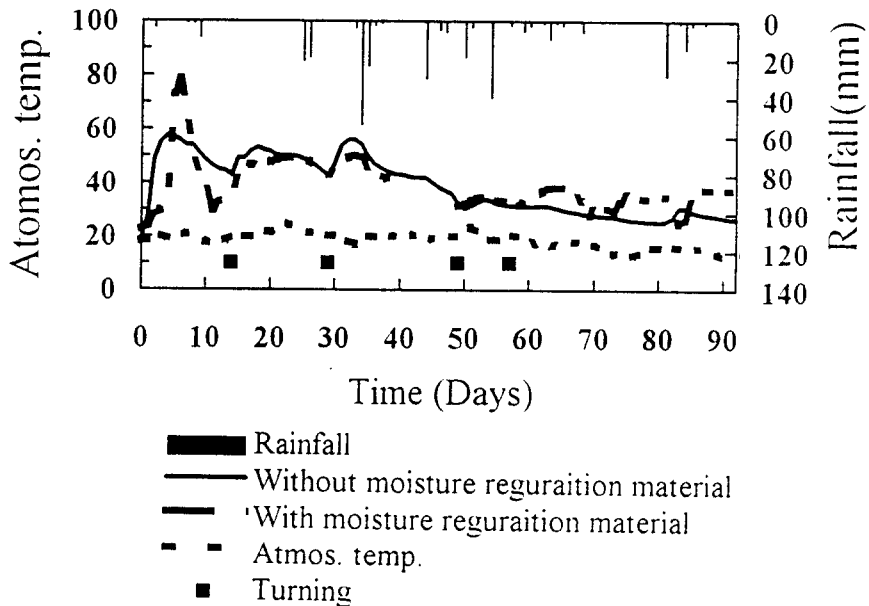


Figure 2. Temperature progress during composting

The increase of temperature begins from just after piling and the temperature has reached 79°C in the 6th day in the ward with moisture regulation materials(organic soil improvement materials), and 58°C in the 4th day in the ward without moisture regulation materials. This shows that the condition of microbial activity is well by the pulverization and mixing at the time of piling. Afterward, 3 turning operations were conducted on every 3 week and compost maturity was judged from a color, stability of temperature, a decrease of C/N ratio, a decrease of NH<sub>3</sub>-N, an increase of NO<sub>3</sub>-N and NO<sub>2</sub>-N.



Photo.1. Windrow - forming work



Photo.2. Turning work

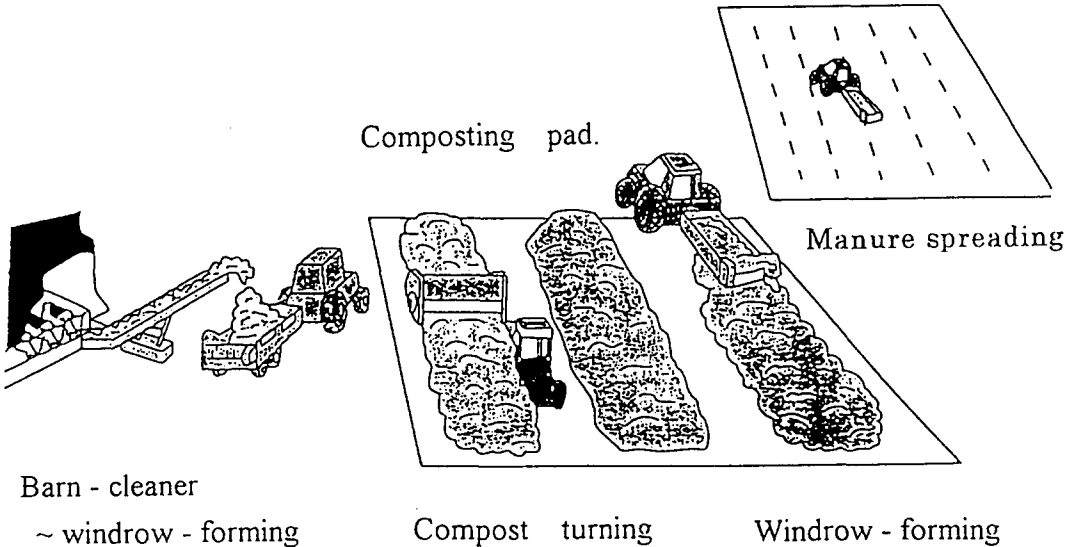


Figure 3. Composting system

## ***5. Area requirements***

The area required for the composting pad depends on the volume of material handled, windrow shape and length and the space needed to maneuver equipment. Moreover, the windrow shape is determined by the composting method and equipment used to form and turn windrow. Here, the required area was calculated as supposing using the windrow-forming car and the compost tuner.

The daily volume of material to be composted from 70 cattle(mean value in Hokkaido) is approximately  $4\text{m}^3$ . If the estimated composting period is 60 days from the experimental result, total material volume is  $240\text{m}^3$ . Assume that the site allows 30m long and that the windrow-forming car can build windrow 1.5m high and 2.5m wide, windrow volume is about  $75\text{m}^3$ . As total volume to be composted is  $240\text{m}^3$ , the number of windrows required is 3 rows. Assume that the space of 2m between windrows (aisle space) is required for equipment movement and that 1m space around perimeter allows, pad width is 15.5m. Assume that the space of 3m for machine movement allows, pad length is 36m. Accordingly, the area required for the composting pad is  $558\text{m}^2$  and about  $600\text{m}^2$  necessity.

## ***6. Conclusions***

As stated above, By combining the windrow-forming car and the compost turner, a simple composting system was developed. Materials to be composted from barn cleaner are received by the windrow-forming car and are piled to composting pad and turning work is repeated in composting process.