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A Glance at the World

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This column comprises notes and info not subjected to peer-review focusing on waste management issues in different corners of the world. Its aim is to open a window onto the solid waste management situation in any given country, major city or significant geographic area that may be of interest to the scientific and technical community.

Estimation of potential methane production of agricultural sector in Korea

In Korea, it is estimated that over 50 million tons of organic wastes are produced every year in agricultural sector out of over 80 million tons (MIFAFF, 2010). The interest of biomass in resource-poor country like Korea is therefore starkly increasing.

In order to make a comprehensive inventory for estimating the potential methane production from livestock waste, agro-industrial waste and crop residues, field visit was firstly conducted to characterize the waste management systems used and to verify the information collected through other sources by sampling the agricultural biomass. Secondary data including national statistical data was used for estimating the methane yield from Korea Statistics.

The annual total dry weight of agricultural crop residues was derived from the rural development administration's (RDA) report. Total and volatile dry weights of livestock manure per year were calculated based on the statistics on the agriculture and forestry. The average fresh manure productions for cattle, dairy, swine, layer and broiler chickens were 8.0, 24.6, 1.6, 0.15, 0.13 kg/head-day, respectively. The average weights of these animals adopted were 350, 473, 111, 1.6 and 1.3 kg, respectively. The annual total dry weight and volatile dry weight for each type of fresh manure were calculated by multiplying the total annual mass of fresh manure by the average percent solids contents (3.8% for cattle, 3.9% for dairy, 4.1% for swine, and 20.3% for poultry) and by the average volatile solids fraction (2.7% for cattle, 2.8% for dairy, 2.6% for swine, and 19.8% for poultry) according to National Institute of Agricultural Science. The total volatile dry weight for all agricultural manure was used for the calculation of potential CH_4 production for this category. Unit factor including manure, urine, and wastewater for each livestock was obtained from the result of pilot scale experiment conducted in RDA in Korea.

Using the Tier 2 method in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, methane potential production for each livestock commodity group (M) and existing manure management system (S) and climate (k) combination are estimated as follows using Eq. (1):

$$CH_{4(M)} = (VS \times H_{(M)} \times 365\ \text{days/yr}) \times [B_{o(M)} \times 0.67\ \text{kg}\ CH_4/\text{m}^3\ CH_4 \times MCF_{S,k}] \quad (1)$$

where

$CH_{4(M)}$ = estimated methane potential production from manure for livestock category M, kg CH_4 per year
$VS_{(M)}$ = average daily volatile solids excretion rate for livestock category M, kg volatile solids per animal-day
$H_{(M)}$ = average number of animals in livestock category M
$B_{o(M)}$ = maximum methane production capacity for manure produced by livestock category M, m^3 CH_4 per kg volatile solids excreted
$MCF_{(S,k)}$ = methane conversion factor for manure management system S for climate k, decimal

In order to calculate the methane production from agro-industrial wastes and crop residuals, two different calculation methods were used as based on data availability. When information of ultimate analysis was available, theoretical methane production was adapted for calculating the methane production. Otherwise, Eq. (3) from IPCC guideline was used for calculating the methane production.

$$C_aH_bO_cN_d + \left(\frac{4a-b-2c+3d}{4}\right)H_2O \rightarrow \left(\frac{4a+b-2c-3d}{8}\right)CH_4 + \left(\frac{4a-b+2c+3d}{8}\right)CO_2 + dNH_3 \quad (2)$$

For crop residuals, calculation method from IPCC guideline was adapted because lack of information was available for element analysis of crop residuals.

$$CH_4\ \text{Emission} = \sum_i (M_i \cdot EF_i) \cdot 10^{-3} - R \quad (3)$$

where

CH_4 Emission = total CH_4 emissions in inventory year, Gg CH_4
M_i = mass of organic waste treated by biological treatment type *i*, Gg
EF = emission factor for treatment *i*, g CH_4/kg waste treated
i = composting or anaerobic digestion
R = total amount of CH_4 recovered in inventory year, Gg CH_4

For emission factor of anaerobic digestion, wet weight basis emission factor, 1 g CH_4/kg waste treated, was used. In addition, two assumptions were made to calculate the methane production with crop residuals. In Korea, the rice straw was collected at 2257 thousand tons (42%) of total yield and then used for the

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feeding forage to cows. If this is used for alternative energy production, it might be assumed as follow; first, 50% of total production of each crop residual is collectable from the field, and second, the utilization rate of crop residuals for anaerobic digestion is ranged from 10% to 30% of collectable crop residuals.

Number of cattle, swine, and poultry was increased about 44.9%, 7.0%, and 26.6%, respectively, from 2005 to 2009 while number of dairy was gradually decreased during this period in countrywide.

Calculated total waste amount related with livestock manure was 37,521 thousand t/y. Among them, swine waste was produced the highest amount of waste as 17,881 thousand t/y account for 47.7% of the total waste amount. The waste produced from cattle occupied 28.4%, 10,674 thousand t/y of the total amount followed by dairy with 14.1%, 5303 thousand t/y of the total waste amount. The least amount of waste was calculated with poultry because of lower unit factor compared to other livestock.

In rice and barley categories, estimated total biomass was 4,186,427 and 24,904 t/y for rice and common barley, respectively. In pulse category, biomass related with soybeans and peanuts was investigated for each province in Korea.

Estimated total biomass for soybeans was 128,071 t/y and 12,296 t/y for peanuts. In vegetable category, four vegetables such as watermelon, carrot, garlic, and green onion were investigated to estimate the organic biomass amount. Estimated total biomass was 10,444 t/y for watermelon, 1165 t/y for carrot, 60,899 t/y for garlic, and 33,518 t/y for green onion. Among them, it was shown that biomass of garlic was the highest. Estimated total biomass for sweet potatoes was 62,960 t/y, and 36,118 t/y for potatoes. Three different oil seed crops such as sesame, perilla seeds, and rapeseed were investigated to estimate the biomass amount. It was estimated that total biomass amount was 103,190 t/y for sesame, 112,758 t/y for perilla seeds, and 4,338 t/y for rapeseed.

Total methane potential production from agricultural waste was estimated to 435,511 t/y. Among three categories, estimated methane production from animal manure showed that the highest amount occupying 71% of total methane production, and was followed by 28% of agro-industrial wastes. Methane emission from crop residuals showed the least amount because of high recycled efficiency for animal feeding stock.

Results of the study suggested that methane emission from livestock manures occupied the highest portion in agricultural sector, and more effective management for livestock waste should be necessary to develop the maximizing methane production in respective to use the alternative energy by using agricultural wastes.

Reference

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Hospital waste management in a developing country: A case study in a tertiary hospital in Southeast, Nigeria

A study has been carried out for evaluating the problems of health care management in limited resource setting such as the tertiary teaching hospital in Southeast, Nigeria. The objectives of the study were aimed to assess the awareness of waste categories among health care workers, and the health care waste management practices in the hospital and to determine, if any the existence of a health care waste management policy.

The study conducted in September, 2012. Ethical approval was gotten from the research and ethics committee of the institution. Verbal informed consent was obtained from the respondents ensuring confidentiality and privacy. The health facility is a teaching hospital which in addition to numerous health services rendered, also trains nurses, undergraduate medical and postgraduate doctors. It serves as a referral center to surrounding communities.

Information on awareness of health care waste categories, handling and disposal practices of waste generated within the hospital was obtained using semi-structured questionnaires distributed by research assistants to 185 health workers (doctors, nurses, laboratory technicians and hospital cleaners) selected by simple random method.

The questionnaires were interviewer administered for the cleaners while they were self-administered to the other cadres of staff. Key informant interviews with heads of departments and units were conducted to obtain information on current waste minimization practices, on-site transportation, storage, treatment and final waste disposal. Information on staff training and the existence of a waste management team in the hospital were also inquired of them.

Direct observation was done using a checklist (WHO, 1999) adopted by the researcher to assess the various waste management practices objectively; waste segregation, transportation vehicle(s), waste treatment, on-site storage and disposal, off-site disposal, sharp disposal practices.

Data was collected and analyzed statistically using proportions. Comparison of characteristics was carried out using chi square test. Information from the interview and direct observation were deducted and described under the relevant headings.

In this study, 185 health workers: 76 (41.1%) doctors, 86 (46.5%) nurses, 10 (5.4%) laboratory scientists and 13 (7.0%) cleaners participated in the study. Among the respondents,57% had worked for more than 10 years while 13% have been working for less than five years.

Fifty-seven (75%) of the doctors, fifty-five (63.9%) of the nurses, six (60%) laboratory scientists and three (23.1%) of the cleaners were aware of the various categories of health care waste as classified by the UNEP/WHO (UNEP/WHO, 2005). On point at which waste should be segregated, 124 (67%) of the respondents correctly said it should be at the point of collection. Among those who answered correctly were sixty-two (81.6%) doctors, fifty-five (64.0%) nurses, six (10.0%) laboratory scientists and one (7.7%) cleaner answered correctly. There was a significant difference in the knowledge of health worker cadre and point when refuse segregation should be done.

None of the respondents (100%) had seen color-coded bags being used in the hospital. Only 23.2% of the respondents knew the designated area within the hospital where waste is taken to for final disposal. On the method for the final disposal of sharps, 109 (59%) of the respondents were aware of the method. Among these 27 (14.6%) were doctors, 78 (42.2%) nurses, and 4 (2.2%) were laboratory scientists.

Key Informant Interview with heads of departments and units: Person(s) designated for the overall collection of waste for disposal: On interview with key informants in the hospital, it was noted that the hospital had one potter (an elderly man) who was responsible for