

Circulation of waste materials, water, CO₂, and O₂, and production of food in a closed system including humans, goats and crops

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Two humans and two goats inhabited and crops were cultivated within the Closed Ecology Experiment Facilities (CEEF). Circulation of waste in addition to circulation of water, O₂ and CO₂, and supply of food and animal feed from crops cultivated in the CEEF was conducted in the experiments. The two humans lived and worked in the Plant Module (PM) and the Animal and Human habitation Module (AHM) of the CEEF during 14-28 days continuously in 2007. More than 90% of amount of their food and animal feed were supplied from 23 crops including rice, soybean, peanut, and sugar beet cultivated in the PM. The excess O₂ in the PM produced by photosynthesis was separated, accumulated, transferred, and supplied to the AHM atmosphere and the waste processing system. The excess CO₂ in the AHM produced by respiration of the humans and animals was separated by the CO₂ separator using solid amine, then accumulated, transferred, and supplied to the PM atmosphere. The water transpired through the crops was collected as condensate, then, reused as a part of new nutrient solution. A part of the condensate was filtered and used in the AHM. The waste nutrient solution discharged from the PM was processed using an UF and a reverse osmosis (RO) membrane filters. Concentrations of nutritional ions in the processed solution were determined, the depleted ions were added back, and the nutrient solution was regenerated. The waste water from the AHM was purified with a RO membrane filter, and then reused for toilet flushing, animal pens washing, and production of new nutrient solution for the crops. The waste including inedible fraction of crops and excretes of the humans and animals were carbonized and incinerated, and then CO₂ and ash were collected. The CO₂ was injected to the PM with that from humans and animals. Potassium extracted from the ash was added to the nutrient solution for crop growing.