# Fate of Organic Amendments Within and Below the Crop Root Zone

*by Dr. Ali Fares, Professor of Watershed Hydrology*

Organic amendments, i.e., compost, chicken and cow manures, have been major sources of macro- (Nitrogen, Phosphorus, Potassium) and micro-nutrients (e.g., Zinc, Magnesium, Calcium) for agricultural crops for centuries. Organic amendments have many benefits for crops, soil and the environment. They are known for improving soil tilth and porosity and to enhance crop yields. Soil physical and hydrologic properties, such as hydraulic conductivity, porosity and bulk density are positively affected with the application of organic amendments. Soil chemical properties, i.e., soil pH and nutrient availability, are substantially improved in soils receiving organic amendments. Research has shown that application of organic amendments that are rich in nitrogen reduces soil-borne diseases by releasing allelochemicals generated during product storage or by subsequent microbial decomposition.

Despite these advantages, improper application of manure may impact the environment through nutrient leaching (e.g., Nitrogen) and greenhouse gases emission. Once leached below the root zone, nutrients are unavailable for plant uptake and may eventually end up polluting our groundwater resources, thus failing one of the objectives of organic farming which is to minimize groundwater degradation by pollutants. Organic amendment decomposition and subsequent nutrient movement with excess water through and below the root zone are function of organic amendment rate and time of application. Studies have been conducted to evaluate some organic amendments under tropical soils, i.e., nitrogen mineralization potential in important agricultural Soils of Hawai'i (Deenik, 2006), soil physical and hydrological properties (Fares et al. 2008), and nutrient concentrations within and below crop root zones.

*Figure 1. The experimental site showing compost and chicken manure bags, drip irrigation system, and two soil solution collection cups per plot.*

During several growing seasons, we investigated soil water content and nutrient availability and leaching within and below the root zone of sweet corn crops, respectively. Figure 1 shows one of these experiments where we studied the dynamics of soil water content and fate of nutrients within and below the root zone of a sweet corn in a Waialua soil at the University of Hawai'i College of Agriculture and Human Resources Waimānalo Research station.

We used commercially available organic compost (CP) and chicken manure (CM) at 4.5 and 3.0 Mg $ha^{-1}$, respectively. These fields were tilled to the top 15-cm depth before and after organic amendment application in the beginning of each growing season of a sweet corn (*Zea mays* L. subsp. mays) and irrigated with a drip irrigation system.

Soil water content and soil solution were monitored at each plot throughout the growing season (Fig. 2). Soil water contents were monitored at 10, 20, 30 and 50 cm depths. Soil solution samplers/lysimeters were installed within (30 cm depth) and below (60 cm depth) the root zone. Soil solutions samples were periodically collected from these lysimeters; then samples were transported in a cooler to the laboratory for nutrient analysis.

*Figure 2. A plot of the compost treatment with drip irrigation system, two soil solution collection cups, a soil water content monitoring probe and its logger, and a weather station.*

Application of organic amendments improved soil water holding capacity and infiltration rates as compared to control treatments. Chicken manure application increased the concentration of nutrients within and below the root zone. This resulted in a higher performance of the sweet corn under CM treatments. However, increase of the nutrient concentrations below the root zone of the CM treatments might result in leaching of these nutrients to groundwater resources.

Farmers must avoid excess application of manure and over-irrigation in order to minimize losses of valuable nutrients and substantially reduce groundwater contamination.

**Additional readings** on the fate of nutrients within and below the root zone and the positive impact of organic amendments on soil hydrological and physical properties can be found in the following articles, respectively:

Ahmad, A. A. Fares, F., Abbas, and J. L. Deenik 2009. Nutrient concentrations within and below root zones from applied chicken manure in selected Hawaiian soils. J. of Environ. Sci. and Health, Part B: Pesticides, Food Contaminants, and Agricultural Wastes, 1532-4109, 44: 828–843.

Fares A., A. Farhat, A, Ahmed, J. Deenik and M. Safeeq. 2008. Response of selected Soil Physical and Hydrological Properties to Manure Amendment Rates, Levels, and Types. Soil Science Journal. 173 (8): 522-533.

**References**

Ahmad, A. A. Fares, F., Abbas, and J. L. Deenik 2009. Nutrient concentrations within and below root zones from applied chicken manure in selected Hawaiian soils. J. of Environ. Sci. and Health, Part B: Pesticides, Food Contaminants, and Agricultural Wastes, 1532-4109, 44: 828–843.

Deenik, J. 2006. Nitrogen mineralization potential in important agricultural soils of Hawaii. Cooperative Extension Service Publication, CTAHR, SCM-15, pp. 5.

Fares A., A. Farhat, A, Ahmed, J. Deenik and M. Safeeq. 2008. Response of selected Soil Physical and Hydrological Properties to Manure Amendment Rates, Levels, and Types. Soil Science Journal. 173 (8): 522-533.

FMI: Dr. Ali Fares
Email: afares@hawaii.edu