Good management practices for land application of vegetable processing wastes

By
Hailong Wang

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BACKGROUND

The vegetable processing industry generates significant quantities of wastes in some regions. These wastes usually contain high levels of organic matter, nutrients, moisture, and sometimes salts, and are not suitable for disposal in municipal landfills because of their physical, chemical and biological properties. Land application is the method most widely used by the food processing industry to dispose of vegetable wastes. Application of such wastes to crop land is often the most affordable waste management alternative as properly applied waste can provide plant nutrients and act as a soil conditioner. Sustainable land application systems should aim to maximise nutrient use while minimising environmental impact.

The purpose of this report is to provide a summary of good management practices for land application of vegetable processing wastes, based mainly on overseas experience.

APPLICATION METHODS

Surface spreading and subsurface injection are the most commonly used land application methods for liquid and solid wastes. To meet the objectives of maximum nutrient use with minimum environmental effect, a number of guidelines for spreading and injection need to be followed:

- Characterise waste to determine nutrient and contaminant contents and select an application rate that does not exceed crop nutrient requirements, avoids harming or contaminating crops, and avoids groundwater contamination.
- Calibrate the spreader to obtain the desired application rate.
- Check soil moisture before applying liquid wastes and adjust the application rate to avoid overland runoff or groundwater contamination through preferential flow.
- Incorporate fresh wastes as soon as possible to prevent odours and reduce nitrogen losses.

Spreading

Liquid wastes (up to 4% solids) can be pumped into a spreader, and special equipment can be used for wastes with up to 15% solids. When spreading liquid waste it is important to limit each application to bring the soil moisture just up to field capacity. If too much liquid is applied at one time it can run off, or leach to shallow groundwater, or move directly into the drainage tile. This can result in water body pollution.

Application of waste may also be limited by soil conditions. Hauling waste in a tank through a wet field may cause soil compaction, but the weight of the tank can be eliminated completely by using a flexible hose to deliver waste to the spreader in the field.

Incorporation and injection

Fresh waste should be incorporated immediately to prevent odours and reduce nitrogen loss. Surface-applied waste can be ploughed under; waste can also be injected about 10-20 cm below the surface, which places it beneath the soil surface without turning the soil over. This minimises disturbance of vegetation, which is particularly important on pasture.

In summary, spreading/incorporation or injection of waste is the most appropriate methods for applying food processing waste. When undertaken with care through testing, calibration and timing of application, land application of food processing waste can add plant nutrients and organic matter to the soil while limiting odours and protecting surface and ground water quality.

POTENTIAL ISSUES

Vegetable processing wastes normally contain high concentrations of organic materials (e.g., high BOD value) and nutrients (e.g., nitrogen, phosphorus, potassium, etc.) which could be assimilated by soil-crop systems. Compared with other industrial wastes, the levels of heavy metals are very low and so this is unlikely to cause a pollution problem. However, sometimes these wastes may contain high concentrations of salts or other chemicals (e.g., caustic or acidic compounds) added during the processing or cleaning stage. These salts and chemicals may have an adverse effect on crop growth or soil properties.

There are short- and long-term environmental effects associated with land-applied vegetable processing wastes.

Short-term effects can be odour and vector attraction (e.g., insects and rates), and dramatic changes in soil pH and salinity. Odour and vector attraction may be minimised by injection below the surface of the land or incorporation into soil, which relies on the soil as a barrier. Odour and vector attraction may also be reduced through waste stabilisation processes such as aerobic or anaerobic digestion, composting, and pH adjustment.

Longer-term effects are likely to be on- and off-site effects related to salt accumulation in soil, nutrient imbalance, and nutrient leaching. Soil salinity and sometimes sodicity (i.e., a soil containing high levels of sodium) because of high levels of sodium salts induced by waste application may cause soil structure damage as well as crop growth reduction. Suggestions for dealing with salt-related problems are detailed in the Technical Review document published by the NZ Land Treatment Collective (Carnus et al. 1998). Nitrogen is the most commonly monitored nutrient associated with land application of vegetable wastes. To minimise nitrate leaching and contamination of water bodies, it is important that the application rate should be based on crop nitrogen requirements, i.e., based on an agronomic rate. If waste is applied to a soil with high phosphorus level and in a sensitive environment (e.g., close to significant fresh water lakes), phosphorus loading also needs to be taken into account.

GOOD MANAGEMENT PRACTICE SUMMARY

Application of vegetable processing wastes to crop land is encouraged by regulators in many countries. Compared with other industrial wastes, restrictions on land application of vegetable processing wastes are usually more relaxed (e.g., New York State Department of Environmental Conservation 1999). The extent of regulation is generally governed by the potential for adverse impacts on the environment, particularly on water quality. The potential water quality impact of irrigating with vegetable processing wastewater is normally considered as minor. Where water quality impacts are likely to occur, operators should be required to prepare and follow proper management plans. Management plans should establish application rates appropriate to the property of the waste, the crop or land being used, and other appropriate agronomic factors. Monitoring should be required as necessary to evaluate compliance with applicable requirements.

The following points may be used as a guide to planning and implementing on-farm management practices for land application of vegetable processing wastes as fertilizers and soil conditioners on agricultural land.

- A detailed site management and operation plan needs to be in place before vegetable processing wastes are used in farm operations.
- Quality of the vegetable processing wastes applied to agricultural lands must meet relevant regulations.
- The chemical and physical characteristics of vegetable processing wastes should be analysed when planning to apply the wastes.
- Suitable soils should be selected for land application of vegetable processing wastes. The most suitable soils are those with few limitations that restrict incorporation of the wastes and/or prevent the on-site use of nutrients in the organic waste (e.g., soil wetness, slope, and texture).
- Application rates of vegetable processing wastes should be based on optimising crop growth and at the same time minimising environmental impacts. The actual application rate is calculated based on the most limiting factor, which is likely to be nitrogen. However, the limiting factor can also be a waste characteristic (e.g., pH, salt content, etc.) or a soil property (e.g., phosphorus, pH, organic matter).
- Special management practices need to be in place when wastes with high levels of salts are applied to land.
- The wastes may be incorporated evenly within the top soil or injected into the subsurface soil; this can reduce odours, ammonia volatilisation, and vector attraction.

- Annual soil testing is recommended to account for residual nutrients in the soil and help determine crop needs and nutrient management decisions. To assess the potential risk to water quality, concentrations of total nitrogen, the carbon to nitrogen (C:N) ratio, and concentrations of plant-available phosphorus in soil are good indicators. For optimum crop production, additional soil testing is recommended, e.g., pH (indicator of soil acidity or alkalinity), electrical conductivity (indicator of soil salinity), and concentrations of exchangeable potassium, sodium, calcium and magnesium.

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