UTILIZATION OF ORGANIC WASTES FOR AGRICULTURE

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Introduction

In temperate zones of the world favorable conditions exist for a well regulated balance between addition of organic materials to soil and their decomposition. Thus, in general, there is a relatively high content of humus in temperate soils and a good organic matter husbandry which leads to maximum effect of mineral fertilizers.

Interactions between organic matter and inorganic soil constituents, especially in the clay fractions, are important factors for high soil productivity. Such interactions also influence the physical properties of soils such as water-holding capacity and bulk density which in turn influence permeability, water availability, rooting of plants, gas exchange, microbiological activity and so on.

Soil organic matter affects soil fertility, by which we really mean the availability and quantity of plant nutrients, by involvement in ion exchange reactions, by chelation of certain metal cations, by releasing or forming biologically active substances and by involvement in microbiological release of nitrogen. Depending upon its nature and origin, organic matter can provide mineral nutrients directly during its decomposition.

Favorable conditions for good organic matter husbandry and maximum benefit from soil humus do not always exist in soils of non temperate zones. Adverse climatic conditions either do not permit build-up of organic matter or have led to clay mineral and other soil constituents of relatively little importance for interactions with humus; in some cases conditions lead to abnormal accumulation of undecomposed or insufficiently decomposed organic material, for example peat soils and mangrove swamp soils.

Problem soils

The beneficial effects of organic matter for helping to reclaim or improve so-called problem soils, are self evident. Unfortunately in many instances, the very nature of the problem in such a soil negates or makes difficult the utilization of added organic matter.

For example, the liberation of plant nutrients is dependent upon the decomposability of the organic material concerned and this decomposability is largely dependent upon microbiological activity. If, as is often the case, a problem soil has poor microbiological activity or a highly specialized, non-relevant activity, organic matter is slow to decompose. As an example consider an acid sulfate soil which by reason of its low pH value will seriously impede microbial degradation of organic matter either by acidity *per se* or by toxicity resulting from liberation of ions such as aluminum; yet microbial activity is not absent and may be very high, but is very specific – activity of sulfur oxidizing organisms for example.

Saline problem soils also inhibit certain phases of organic matter decomposition although the precise mechanisms are yet to be satisfactorily explained. It has been established that salts depress the solubility of organic matter and it is the soluble fraction that is most readily decomposed. Generally also, an increase in osmotic tension reduces oxidation of carbon; its effect upon nitrification is in dispute.

Although organic matter decomposes over a wide range of soil moisture content, from less than wilting point to saturation, in very wet soils the rate of decomposition falls off due to lack of oxygen and thus organic matter tends to accumulate in soils that have a problem of drainage and

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waterlogging.

Then again, in temperate climates, addition of organic material such as a green manure, to soil results in an increased amount of soil organic matter; but in a problem soil of an arid or very hot region the decomposition is too rapid to enrich the soil.

Desert soils, saline and saline-alkali soils need physical conditioning as they are not well textured and this is the most important role of added organic matter although the effect upon increased cation exchange activities must not be overlooked. Soil texture and structure are affected mainly by the high molecular weight constituents of humus which are cellulose, lignin, pectin and proteins. Nowadays, commercial organics such as polyacrylics are used to improve poor textured soils but these are expensive and out of reach of the average farmer – especially those farmers dependent upon problem soils. Thus the use of naturally available organic materials is to be encouraged.

The problems of utilizing organic wastes

The actual use of organic wastes for agriculture is not entirely a straightforward operation. This was brought out by the near-universal change-over to mineral fertilizers when they became generally available in Asia in the mid-sixties. Just as one example we can note that in Japan the use of organic manures on paddy fields dropped from 6.5 ton/ha in 1955 to 2.7 ton/ha in 1975, this being paralleled by an increase of from 0.08 ton per hectare to 0.30 ton/ha in use of mineral fertilizers. The reasons for abandonment of organic manures in favour of mineral fertilizers are the greater ease of handling, storing and application of the latter together with their quick and dramatic results.

Organic materials, especially those thought of as wastes, are, in general, very bulky; they also are usually in a physical state making handling and transport difficult and moreover, are invariably unpleasant to sight and smell. Thus their neglect in favour of mineral fertilizers is easy to understand but, the policy was short-sighted as the mineral plant nutrient aspect of organic manuring is relatively unimportant in comparison to its effect upon soil conditions. Nevertheless, the sheer bulk and nature of organic wastes remains a problem for their use as collection, storage, transport and application are difficult, time consuming and labour intensive.

Another problem is availability or rather, knowledge of availability. Very often the amounts of a certain waste are estimated on false assumptions. For example in India, figures for the availability of cattle dung have been published and interpreted into so many tons of plant nutrients and even to so much potential yield increase. Yet the original figures were estimated from the total number of cattle in the country; no allowance was made for the considerable amounts of dung scattered over the countryside by free-running animals or the very large amounts burnt as fuel in the villages. There is a need for factual surveys to determine exactly how much and of what kind of organic wastes are realistically actually available for recycling in soils.

Yet another problem is the purely technical one of how to best use the organic wastes. At present organic manuring is an art and often a very inefficient art; it must be developed into a science. The methodology of applying mineral fertilizers, soil amendments and soil conditioners has received and is receiving global and intensive attention. Laboratory and field experimentation has filled our journals with statistics, data and argument. Much of this experimentation has resulted in more efficient use of the materials investigated; one example could be the tremendous advance made in placement of nitrogen fertilizers that tend to be denitrified. No results of such experiments exist for organic manures; who knows what significant findings would result from trials on placement, quantity, time and frequency of application and so on, using organic materials?

Organic recycling in Asia: the present position and future prospects

A recent World Bank study estimated that the world is spending two hundred billion dollars a year in disposing of its organic wastes. Therefore replacing the concept of disposal with that of recycling has vast economic implications as well as those of soil and environment improvement.

The FAO/UNDP regional project for improving soil fertility through organic recycling came about in 1978 as a result of a World Food Conference recommendation and a Workshop held in Bangkok. The project has as its main objective to encourage and assist countries to utilize organic materials to increase soil productivity rather than allowing them to become wastes.

The project has seventeen participating countries which shows the interest in the subject in the region. Each of these countries now has at least some national program involving organic recycling and certain countries, for example China, India and the Philippines, have very large scale organic recycling programs involving considerable national investment.

The activities now being undertaken in Asia under the auspices of the FAO project include agricultural use of urban wastes such as city garbage and sewage; use of rural wastes such as crop residues and animal wastes; use of organic industrial wastes; development and use of biofertilizers and green manures and; the development of integrated farming involving animal husbandry, crop production, aquaculture including pisciculture, green manures and biofertilizers, all based upon complete recycling of wastes with the side product of energy as biogas.

A specific example of current activities applicable to this Symposium is research on the reclamation of acid sulfate soils in Thailand using *Azolla.* Another is the production of blue-green algae in saline desert soils of Pakistan. In Malaysia agricultural uses for peat are being investigated and in Indonesia experiments are planned on the use of compost for reclamation of Red-Yellow Podzols.

Certain research institutes and Universities have been given contracts by the project to investigate, *inter alia*, mode and frequency of application of organic materials, complementary effects of organic and mineral fertilizers and, production of compost and biogas at sub-ambient temperatures. It is hoped to formulate a scheme for introducing a survey of availability of organic wastes into national rural census programs and at least two international training centres for organic recycling are expected to materialize in the near future.

In conclusion, it is of interest to note that FAO is extending its influence and activities in organic recycling to other regions than Asia.

Programs, although not as yet on the scale existing in Asia, are being formulated in organic recycling for East and West Africa, Latin America and the Near East. Thus very soon nearly all the problem soils of the world will be under attack by those encouraging the agricultural use of organic wastes.

Discussion

Hew, C.K. (Malaysia): In the FAO study-project on the use and application of organic wastes and fertilizers, are the hygienic and health aspects being considered? If so what are the results?

Answer: So far, the only really efficient control of health and sanitation aspects of organic wastes recycling is by including anaerobic digestion as a preparatory waste treatment, i.e. biogas technology.

Tanaka, A. (Japan): I believe that the term "waste" is somehow inappropriate in the case of straw of rice or wheat as these materials contain plant nutrient elements and are generally returned to the soil.

Answer: I agree with you and in fact I believe that there are no "waste" materials but there is often a waste of materials.

Tanaka, A. (Japan): You showed a picture taken in Korea where part of a wheat field which had received compost (there was no precision about the nature of the compost) in addition to chemical fertilizer showed better crop growth than the part which had received chemical fertilizer only. Do you imply that organic substances have some unique effect on soil or act as additional nutrient to wheat?

Answer: I interpret these data as follows: I believe that compost had improved the problem soil so as to maximize the use of the mineral fertilizer.

Ando, T. (Japan): I agree with you that the utilization of organic materials for agriculture should be promoted in order to increase crop productivity. However it is often necessary to apply a large amount of such materials to obtain a significant increase in crop production and some of the organic wastes from industries or human excreta sometimes contain a large quantity of salts and/or heavy metals. Could these eventually lead to decreased crop productivity due to toxicity?

Answer: This is a very pertinent question and hardly any work has been done on this aspect. Most countries have legislation on heavy metal limits in sewage that is to be applied on land, but each country has different limits. Increased attention is being paid to the use of water hyacinth for agriculture (compost and biogas production) and yet this plant can accumulate very large amounts of heavy metals. Yet no research has been made on this aspect. FAO is thus encouraging an investigation into heavy metal effects of water hyacinth and is assuming the responsibility for standardizing heavy metal limits of sewage/sludge.

Goswami, N.N. (India): Is the FAO preparing any documentation/report on the different organic materials, their composition, associated problems and possible influence on the soil when applied in large quantities? 2) Do you think that all kinds of organic materials could be put into the conventional biogas plant?

Answer: 1) Yes, we are intending to prepare such documentation and a consultant has been recruited to start this work. 2) Yes, with proper management.