THE TECHNOLOGY OF EFFECTIVE MICROORGANISMS – CASE STUDIES OF APPLICATION

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ABSTRACT

The technology of Effective Microorganisms (commonly termed (EM Technology) was developed in the 1970's at the University of the Ryukyus, Okinawa, Japan. The inception of the technology was based on blending a multitude of microbes, and was subsequently refined to include three principal types of organisms commonly found in all ecosystems, namely Lactic Acid Bacteria, Yeast Actinomyces and Photosynthetic bacteria. These were blended in a molasses or sugar medium and maintained at a low pH under ambient conditions.

The technology was introduced to the world through an International Conference held in Thailand in 1989, where a research program to test its efficacy was undertaken by 13 countries in the Asia Pacific region. Thereafter, this program encompassed many international fora, including the International Federation of Organic Agriculture Movements (IFOAM).

The original concept of using EM in crop production, primarily in organic systems to overcome the inherent problems such as low productivity was well proven in many environments. Thus the technology spread gradually to all continents.

Today EM is used in many systems pertaining to agriculture and environmental management. These range from crop and animal production systems, to livestock and aquaculture units. EM is used widely in environmental management for decomposition and more importantly for recycling of wastes, both solids and liquids. More recently research from Japan and projects in the USA have reported the ability of EM based products to reduce dioxin contents.

The programs on EM undertaken in over 60 countries show its success. The initial research undertaken in agriculture paved the way for case studies and large-scale use of EM in a diverse range of environments. These include laboratory scale identification of the microbes and their role in the DPR Korea, to the use of the solution in crop production in over 500,000 hectares in the same country. It is used in the USA, Europe, Africa, Asia, Mid and South America and Oceania in a multitude of ways. The reports from these projects highlight successes although some do show marginal results. The important aspect has been its use by practitioners, who adopt technologies due to proven successes and not research reports. The presentation will cover the practical benefits of using EM on the basis of research results and case studies where the solution has been used extensively for either agriculture or environmental management.

INTRODUCTION

The 21st century has dawned, with renewed hope for a better livelihood for the populations of this earth. Hence the themes often discussed at international fora on human welfare and agriculture range from sustainability, food security and safety to the provision of a productive and healthy environment to humankind and its future generations. Hence there is often a great deal of optimism about the possibilities of solving the multitude of problems in relation to the provision of food and a clean healthy environment for all.

Although the picture being painted seems rosy with numerous possibilities, the reality is not that simple. The future is not too optimistic. The post war agricultural revolution has brought about problems of pollution, which are increasing in magnitude, although the agricultural development projects have increased yields in both developed and developing countries. The problems also arise from over production of agricultural commodities in the developed countries, while inadequate production and unequal distribution of food and resources in the developing countries is a common phenomenon. There is excessive pollution caused by industrialized agriculture, loss of biodiversity and increased incidence of pests and diseases. The use of genetically modified organisms has raised concerns about food safety. All these problems need solutions to maintain and possibly enhance the quality of the environment and provision of food for humankind and also all forms of life on earth (HRH The Prince of Wales, 1998).

ORGANIC OR NATURE FARMING

Organic or nature farming is considered a possible solution to many of the problems caused by industrialized agriculture (Litterick et al, 2001). This is based on the fact that organic or nature farming is a holistic concept, involving all components of the ecosystem. Hence organic and nature farming are considered useful and sustainable systems to produce safe and quality food, both in the developed and developing world.

Organic farming in the developing world is viewed as a system of alternative agriculture, which could enhance the quality of degraded environments currently farmed intensively by smallholders to produce food and fodder. In the recent past, organic products have also become export commodities, which earn much-needed foreign exchange to these countries. In all instances, organic farming alone may not provide the required quantities of food, although it certainly has the potential of improving the environment and more importantly, the sustainability of the farming systems.

A primary problem of organic or nature farming is the low yields procured, when compared to that of conventional chemical farming systems. This is principally observed in the developing countries. Hence the promotion and development of organic systems in these regions must be coupled with technologies that would enhance yields while preserving and possibly improving the sustainability of the systems and also the environment.

MICROBES IN AGRICULTURE

Microbes are a vital component in all ecosystems. In agriculture, their value cannot be overemphasized, due to their role in the soil and as an interlink between the biotic and abiotic components and also between the grazing and detritus food chains. However, their role has often been neglected in conventional chemical farming systems. The interaction between microbes and plants developed with the process of evolution in plants, and hence the use of microbes singly or in mixtures of free living and naturally occurring species could enhance the productivity of most farming systems significantly (Zarb et al, 2001). Thus the most importance and often-used species of microbes in agriculture are Fungi, Bacteria, Actinomyces and Yeast.

Although the use of microbes in the form of animal manure and slurries has a long history in traditional agriculture, the use of Rhizobium and Mycorrhizal inoculation added a new dimension to the technology of microorganisms in agriculture. In the recent times, research has clearly shown the benefits of using inoculations of naturally occurring microbes in increasing productivity of both conventional and organic farming systems (Tisdal, 1994, Zarb et al, 2001). However, the use of microbial inoculation containing many species obtained from the respective ecosystems to develop multiple benefits has not received much attention.

THE TECHNOLOGY OF EFFECTIVE MICROORGANISMS

Fungi, Bacteria, Actinomyces and Yeast are found in all ecosystems. They are used widely in the food industry, and these species play a vital role in agriculture to maintain and also enhance productivity (Zarb et al, 2001). The technology of Effective Microorganisms (EM) also uses these species namely Lactic Acid Bacteria, Photosynthetic Bacteria, Yeast and Actinomyces isolated from the respective environments in which EM is used.

Professor Dr Teruo Higa developed the technology of EM in the 1970's at the University of the Ryukyus, Okinawa, Japan. The first solutions contained over 80 species from 10 genera isolated from Okinawa and other environments in Japan. With time, the technology was refined to include only the four important species cited earlier, namely Lactic Acid Bacteria, Photosynthetic Bacteria, Actinomyces and Yeast. These are isolated from the respective locations where EM is used extensively and is blended into a mixture in a sugar-based medium. The sugar commonly used is molasses or raw sugar, and the solution is maintained a low pH ranging between 3 .0 – 4.0 The mixture does not contain any organism imported from Japan, nor does it contain any genetically modified organisms. Hence, EM is made in over 40 countries in all continents, from species isolated from the different localities. The technology is thus safe, effective and environmentally friendly, and is accessible to farmers in both developed and developing countries. On this basis, the technology is used or researched upon in countries ranging from Austria to Zimbabwe.

PRACTICAL USES OF EM

The practical uses of EM can broadly be classified into two principal components –

i.e. Agriculture
Environmental Management

The research programs and case studies on the benefits of EM in these two principal components have been reported from all continents of the world. However, a setback in the wide scale publicity of these very useful studies has been the lack of publications in international journals, due to the emphasis on one particular product. Most studies have been reported at two fora, namely the International Conferences of IFOAM (International Federation of Organic Agriculture Movements) beginning 1987 and the International Conferences on Kyusei Nature Farming beginning in 1989. However, the usefulness and potential values of the technology is accepted internationally as shown by the development of separate sessions on EM at the IFOAM conferences beginning in New Zealand in 1994.

EM IN AGRICULTURE

The original use of EM was for agriculture. Hence EM was first applied to enhance productivity of organic or nature farming systems. EM was applied directly onto organic matter added to cropping fields, or to compost, which reduced the time required for the preparation of this biofertilizer. EM is also added in the form of Bokashi (Compost) made with waste material such as rice husk and saw dust as a carrier, mixed with nitrogen rich material such as rice, corn or wheat bran, fish meal or oil cakes.

The studies on the success of EM in crop production are many. Research on papaya in Brazil (Chagas et al, 2001), herbage grasses in Holland and Austria (Bruggenwert, 2001, Hader, 2001), vegetables in New Zealand and Sri Lanka (Daly and Stewart, 1999, Sangakkara and Higa, 2000) and apples in Japan (Fujita, 2000) illustrates this phenomenon very clearly. All these studies are examples of a multitude of projects and they clearly highlight that the use of EM or EM based products such as Bokashi increase yields of traditional organic systems over a period of time.

The causal phenomenon of these results has been attributed to many factors. These include greater release of nutrients from organic matter when composted with EM (Sangakkara and Weerasekera, 2001) enhanced photosynthesis (Xu et al, 2001) and protein activity (Konoplya and Higa, 2001). Studies also identify greater resistance to water stress (Xu, 2000), greater mineralization of carbon (Daly and Stewart, 1999) and increased soil properties (Hussein et al 2000) and better penetration of roots (In Ho and Ji Hwan, 2001) with the use of EM.

The impact of EM in promoting plant growth by controlling or suppressing pests and diseases has also been reported from many countries. Kremer et al (2001) reports the control of Sclerotinia in turf grass with EM. Guest (1999) and Wang et al (2000) highlight the control of Phytopthora with EM derivatives in China and Australia Wood et al (1999) also states the control of pickleworm in cucumber with EM. The control of black Sigatoka with EM is a success in Costa Rica (Elango et al, 1999). These are just a handful of many reports that present the success of EM in crop production. More importantly, all these highlight the benefits of EM in a wide range of environments. which is the key to its success and adaptability.

The use of EM in animal husbandry is also clearly identified in many parts of the world. Studies in Asia where EM was first introduced and is used extensively (e.g. Chantsawang and Watcharangkul, 1999) and in Belarus (Konoplya and Higa 2000) report the successful use of EM in poultry and swine units. EM is added to feed and sprayed for sanitation in these units. Integrated animal units and poultry farms in South Africa (Hanekon et al, 2001, Safalaoh and Smith, 2001) use EM to increase productivity. Swine units and fish units in Austria also use EM for procuring greater productivity (Hader, 2000).

The causal phenomenon of these has also been identified in research projects. These are greater physiological activity in animals and better feed conversion efficiencies (Safalaoh and Smith, 2001, Konoplya and Higa, 2000).

As cited earlier, the reports on EM in increasing the productivity of animal units are numerous. The setback in further progress is the lack of international publications of these studies, although carried out in a systematic and scientific manner. However the benefits are clearly identified as exemplified by the adoption of the technology by farmers and producers despite warning by skeptical scientists. This is the final judgement of the success of the technology for agriculture.

EM IN ENVIRONMENTAL MANAGEMENT

The management of the environment is a key and controversial issue in modern agriculture. The disposal of farm wastes, the discharge of polluted waters and the mitigation of dioxin developed through incineration or disintegration of wastes are all problems faced by humankind. Thus legislation is being introduced in many countries to preserve the existing environment and possibly improve it.

The role of EM in environmental management is of significant importance. This microbial solution, which was originally developed for nature or organic farming systems, was further expanded to overcome environmental issues, thereby facilitating the reuse of most wastes.

The first concept of using EM in environmental management was in the process of composting. Crop residues and animal wastes were effectively composted to produce biofertilizers. Research in Holland (e.g. van Bruchem et al, 1999), and Shintani et al (2000) in Costa Rica highlight the potential of making compost with animal or crop wastes, this increasing yields of crops supplied with this material, over the productivity of traditional organic systems.

The use of EM in composting garbage developed in the mid 1990's and very successful projects have been undertaken in Asia. A good example is that of Hanoi Vietnam (Quang, 2000), under the purview of the Ministry of Science, Technology an Environment of that country. The city garbage is composted with EM and sold as fertilizers. A similar project is being undertaken in Yangon, Myanmar. The city of Pusan in Korea uses EM in over 500 apartments to compost kitchen wastes, which are recycled into home gardens, in a project undertaken by the Red Cross. The city of Christchurch in New Zealand is also undertaking a similar project, which will be a field site at the International Conference on EM in January 2002.

EM is also being used effectively in purifying water for reuse. The best example of this is in Okinawa the home of EM. The city library of Gushikawa uses EM very effectively in treating sewage water, which is recycled for the garden and in toilets. The COD and BOD of the water are reduced significantly when treated with EM (Okuda and Higa, 1999) and this water is reused, thus saving costs and energy.

A very recent project on using EM in water treatment is in the Gold Coast of Australia, in the city of Mc Kay. The city sewage system is treated with EM and oxygen and the quality of water enhanced prior to discharge. A resort island uses EM for its water treatment and this water is recycled into gardens with no smell. The quality of water is well within the stringent environmental laws of Australia, and this study will be presented in New Zealand next year.

Research in South Africa also highlight the potential of using EM for treating pig manure prior to feeding fish (Hanekon et al, 2001). Addition of EM to pig fed promoted growth of the animals. Application of EM to manure reduced faecal bacterial counts and feeding this manure to fish increase harvestable produce.

Although not recorded, there are many projects using EM for waste management in many countries. Amongst all the practitioners of EM, the best example is at the Nature farm in Sara Buri, Thailand, where EM is used for cropping, livestock, and waste management. Unfortunately these results have not been recorded as it is a practical farm used extensively for training people from Thailand and overseas on EM technology, at no cost to the trainees.

The most recent studies with EM on environmental management produced very interesting results. If repeatable, these would have a significant impact on the enhancement of environmental quality. The first is a study from Belarus, which illustrate the ability of EM to reduce radioactive contamination in affected soils (Konoplya, 1999). Application of EM increased uptake of Cs137 from contaminated soils of Chernobyl. The destruction of these crops would reduce the level of contamination in the soils. In addition, the use of EMx, a derivative of EM, which has antioxidant properties, was seen to act as a radioprotective agent.

The second and third studies relate to the reduction of dioxin production. A pilot study in the USA (Kozawa 2000) showed that the use of EM could reduce dioxin production. More importantly, a study by Miyajima et al (2001) in Okinawa, report that using EM in a commercial incinerator reduced the production of dioxin. These suggest valuable lines for research ad acceptance for the future.

CONCLUSIONS

The potential of EM in agriculture and environmental management is significant. The technology can be used easily and economically to enhance productivity of agricultural systems, especially organic systems and in mitigating environmental pollution.

While successful projects are being implements in many countries even at national scale as in Myanmar, D P R Korea, Vietnam and Thailand, and by non governmental organizations as in Sri Lanka, India and Indonesia or on a more localized scale by private organizations such as New Zealand nature farming Societies, Agriton of Holland, EMROSA of Africa, a setback has been the lack of proper exposure and recording of results. The users see the benefits of EM and there is a very growing demand for EM. This calls for the maintenance of good records of its success and effects, although the users often state – "We know its benefits – Why record it?"

In this story of success, one also needs to be cautious in using EM. It is not a means or answer to all problems, although it has a significant role to play in agriculture and environmental management. As in all techniques, EM must also be used diligently and with care, as per guidelines. Failure to do so would produce negative results as in some instances, which have also been given publicity. However, adoption of the technology of EM will ensure the achievement of the objective – Where all humans of this world strive for – Greater production of agricultural systems on a sustainable basis and a cleaner environment for humankind and its future generations.

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