Country Report of Malaysia

BIOFERTILIZERS IN MALAYSIAN AGRICULTURE: PERCEPTION, DEMAND AND PROMOTION

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INTRODUCTION

Since the beginning of the “Green Revolution” in the early 1970’s, which focused on food crop productivity, through high-yielding varieties, agrochemicals and irrigation system, chemical fertilizers were extensively used throughout most of agricultural Asia. In fact, Asia is the world's largest user of chemical fertilizers, consuming around 40% of the global total each year. The emphasis on chemical fertilizers, which sometimes led to injudicious application, has meant that the soil be regarded as an inert substrate for plant roots, instead of a living biosphere, the rhizosphere, containing a myriad of organisms. It is now realized that in agricultural lands under intensive monoculture system, including paddy rice, which receive heavy applications of chemical fertilizers alone, productivity is slowly declining, and environmental quality is deteriorating too. In the light of these problems, the use of organic fertilizers, biofertilizers and other microbial products is crucial in the current attempt to make the agriculture industry a viable component of a healthy and pleasant ecosystem.

THE MALAYSIAN SCENARIO

Use of industrial scale microbial inoculants in Malaysian modern agriculture started in the late 1940’s and peaking in the 1970’s, with *Bradyrhizobium* inoculation on legumes, especially leguminous cover crops (LCC) taking precedent (Shamsuddin, 1994). This period coincides with the boom time for extensive cultivation of plantation crops, first the rubber trees, *Hevea brasiliensis* (2 million ha in 1999), and later followed and overtaken by oil palm, *Elaeis guineensis* (3.3 million ha in 1999). The Malaysian Rubber Board (MRB), formerly known as Rubber Research Institute of Malaysia (RRIM) has been instrumental in research on *Rhizobium*, mass production of rhizobial inocula, as well as widespread use of rhizobial inoculum for leguminous cover crops in the interrows of young rubber trees in the large plantations. These LCCs were established in plantations newly transplanted with rubber or oil palm seedlings, and their significant contribution was not so much the transfer of legume nitrogen to the principal crops or improvement of soil fertility, as the protection of bare soil against erosion and moderating water losses in the warm tropical climate. The young rubber trees also benefit from the mineralizable nitrogen released during the decomposition of the legume residue. Leguminous cash crops including groundnut (*Arachis hypogaea*) and beans cultivated in the interrows of rubber and oil palm have also been inoculated with rhizobia at planting. However, this practice of intercropping, as in the hedge-planting system, has not being well accepted by the plantations and smallholders in Malaysia since it is labour intensive.

Microbial inocula with a longer history were the starter cultures for small-scale compost production, passed from generation to generation of farmers. This was passed along with knowledge that the cultures would be able to accelerate decomposition of organic residues and agricultural by-products through various stages, with a concomitant release of plant nutrients through mineralization processes, as evident from the good, healthy harvest of crops. A decomposer fungus, *Trichoderma reesei*, combined with the nitrogen fixing bacterium *Azotobacter* was reported to produce compost within a shorter time, and has a higher nitrogen count. Taking further the use of decomposing microorganisms, a prospective area is the reclamation of sandy, weathered and spoiled land (mainly as a result of mining and related activities). Currently, there are about 200,000 ha of unproductive sandy soils in Malaysia, with poor physical and chemical characteristics, low organic matter and fertility status and high daily temperature of about 42 $^{\circ}$C. Arshad *et al*. (1994) reported that these land areas has potential to be reclaimed for agriculture if properly treated and managed, for example, incorporation with organic matter and inoculation with selected high-temperature tolerant cellulose decomposing bacteria (e.g. *Bacillus pumilus* PJ19 and local isolates S101, S107, B8). The concept of nature farming, aiming at producing safe food without using agrochemicals “while utilizing the intrinsic productivity of soil and maintaining the harmony of the natural ecosystem” was introduced to Malaysia recently. A few small-scale experiments were conducted using the commercially supplied 'EM' on several crops. However, the idea has not taken off much further on a more commercial and viable scale.

A biofertilizer that is increasingly being utilised and accepted in the agriculture industry of Malaysia is the mycorrhiza inoculum. Mycorrhizal research in Malaysia has been prominent since the 1980’s, mainly through works conducted at Universiti Putra Malaysia (Azizah-Chulan, 1991). Many mycorrhiza-based products have been developed and produced in large scale locally for one or combination of the following purposes: improved plant nutrition, soil fertility improvement, root pest and disease control, improved water usage, amelioration of toxic effects in soils. The users are those involved in industries of plant nurseries (oil palm, fruit trees, forest trees, ornamentals), lawns, golf courses, forest replanting, and soil reclamation. The substrates for the production of mycorrhizal inocula are abundant: mine sands, paddy rice straws and other agricultural wastes. Effective mycorrhizal fungal strains for different crops and for different “purposes” have been screened and maintained for use as starter cultures in mass production of mycorrhizal products.

PERCEPTION ON BIOFERTILIZERS

The current strategy of marketing biofertilizer products in Malaysia is through niche markets (e.g. ornamentals, vegetables, forestry). The scope for a particular biofertilizer product is often perceived to be limited. For example, rhizobial inoculum could only be applied to legumes, whether the grain legumes (such as groundnut, soybean, mungbeans) or the leguminous cover crops (*Centrosema, Pueraria, Mucuna, Calopogonium*). Effective or successful symbiosis between the rhizobia and the legume roots will result in high efficiency at fixing atmospheric nitrogen, and subsequently less dependence on chemical nitrogen fertilizer. In terms of the environment and economy, the use of biofertilizers is thus desirable. However, chemical N fertilizer is applicable to all crops, and not limited to a particular group of crops such as the legumes. Currently, grain legumes are no longer produced in large scale in Malaysia, and in rice producing areas of the country crop rotation of rice-legume-rice is not in practice, since double cropping per year (or sometimes 5 times in 2 years) is adopted. There is also no long fallow period between the rice planting seasons, thus rendering decomposing materials in the fields not readily available for the immediate planting season. The use of rhizobial inocula produced in Malaysia is for inoculating LCC in lands belonging to large plantation companies, which are undergoing replanting with oil palm or rubber. Smallholders and the ordinary farmers do not use microbial inoculum for the LCC, or not using the LCC at all. *Shamsuddin et al.* (1992) reported that a major constraint to a successful rhizobia-legume symbiotic association in Malaysia is soil acidity. Soils with low pH, phosphorus and calcium concentrations, and the high aluminium concentration affect rhizobial growth, as well as the legume, and thus affecting symbiosis. Hence, screening for effective acid-tolerant rhizobial strain is essential for a successful biological nitrogen fixation programme.

Biofertilizers are often perceived to be more expensive than the chemical fertilizers. This is more so, since the farmers and smallholders received fertilizers heavily subsided by the government (currently at RM 500 million per year fertilizer subsidy). Thus, only those nursery and farm operators who appreciate the benefits of certain biofertilizers will use them.

Another perception on biofertilizer is that its effect on the crops is slow, compared to chemical fertilizers. Special care (e.g. storage, mixing with powders, etc.) is also needed to handle microbial inocula so that they remain effective for extended use. These inoculants, too, favour certain environment. Concerning microbial inoculants, while some users realise their potential there was difference of opinion on the effectiveness of microbial inoculants available in the market. Some felt that the performance of these products is often disappointing, unreliable, and not as claimed by the manufacturers. Some products, however, do give good results. All these perceptions contribute to influencing the users on the use of microbial inoculants and biofertilizer products. The way forward is to produce that may satisfy the users in terms of versatility, ease of use, and cost.

DEMANDS FOR BIOFERTILIZER PRODUCTS

As the agriculture industry become more aware of the need to adopt more environmental-friendly approach in providing plant nutrition and sustaining soil fertility, in tandem with increased productivity, biofertilizers have a substantial role in it. Biofertilizer products most suitable for the small farmers, the large plantation, forestry and recreational industries will be ones that meet their requirements and expectations. In Malaysia, mycorrhizal products are perceived to be more versatile that the others, and can be tailor-made to address particular problems. This include the use of mycorrhizal inocula on landscape plants (Raja *et al*., 2001). Currently there are several companies in producing mycorrhizal products, through locally developed technologies. Much research, since the early 1950's have been conducted on the effectiveness of mycorrhizal inocula on plantation, horticultural and food crops, pastures and lawn, as well as forest trees. The substrates for production of mycorrhizal inocula are easily available, using the following natural resources: sand from ex-mining lands, ground cocoa shells, sweet potato tops, rice husks and rice straw. Generally, the appeal of the mycorrhizal inocula in the Malaysian market is on the rise.

Unless there are other potential uses of the rhizobial inocula, the market for it in Malaysia is limited. This is because no grain legume production going on in the country and the acreage of rubber and oil palm is slowly decreasing. However, there is potential for use of *Azorhizobium* inoculum on some N-fixing agroforestry or green manure species including *Sesbania rostrata* (Saud *et al.,* 1993).

Biofertilizer products with some potential market in Malaysia will be those based on *Azospirillum*, the associative nitrogen-fixing bacteria. Research has been initiated in Universiti Putra Malaysia to evaluate the contribution of nitrogen from *Azospirillum* to oil palm seedlings. Shamsuddin (1994) reported through ^{15}N-labelling technique it was measured that up to 89% of the nitrogen requirement of oil palm plantlets inoculated with *Azospirillum* and grown in a liquid media came from the bacteria. The bacteria probably has great potential in rice production too, as was reported for maize, kallar grass, sorghum, millet (Dobereiner and Pedrosa, 1987).and sweet potato (Shamsuddin, 1994).

PROMOTION OF BIOFERTILIZER

Although the price of biofertilizer and microbial inoculants are quite expensive, farmers tend to be more receptive to them than the large plantation industries and the scientific community. Some products do perform as claimed by the manufacturers while others are dissappointing. As biofertilizers contain living organisms, their performance therefore depends on whether the environment they are introduced to are conducive. Hence, outcomes are bound to be inconsistent. Some of these small-scale farmers may be more skilled in manipulating the products by selecting or creating a good environment for the microbial cultures in their plot of land.

For the big players in the plantation industry, the biofertilizer products should be versatile, easy to handle and cost-effective. They could be used together with chemical fertilizers to give good results. The use of chemical fertilizers have been entrenched in the industry, that it is difficult to shift to biofertilizer, and furthermore biofertilizer on its own may not be sufficient in modern, high-productivity agriculture. It could be seen in the Malaysia scenario that mycorrhizal products fit the requirements of the industry.

RESEARCH PROGRAMMES ON BIOFERTILIZER
(Emphasis given to Mycorrhizal Products)

Year 2002-2004

a. Proposed MINT-MAH joint research on:
   - Encapsulation of arbuscular mycorrhizal fungi (AMF)
   - Mass production of AMF through tissue culture of host plants

Researchers: MINT, MAH
Facilities: Gamma irradiator for sterilisation of substrates, tissue culture laboratories, greenhouses, isotopic tracer study laboratories
AMF cultures: available locally

CONCLUSION

There is great potential for the biofertilizer industry in Malaysia, producing products from local sources and natural resources. Interest on the part of researchers is high as well as would-be partners in the industry. It is envisaged that mycorrhizal biofertilizer products will greatly appeal to the Malaysian agricultural industry mainly due to its versatility and use of environmental-friendly technology. Quality control of products is of great importance. This is always a challenge with microbial products, because the mass production of living organisms tends to select those best suited to mass production, rather than those which are most effective in the field. Research in the field, aided by nuclear technology will enhance biofertilizer use in the country.

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