Kyusei Nature Farming in Thailand: Research and Extension Activities

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Introduction

Although Thailand is an agricultural country, it is now moving rapidly toward an agricultural /industrial orientation with two major problems. The first is low efficiency in agricultural production as a result of high input costs, the second is an advancing environmental deterioration resulting from pollution. These problems have originated mostly from improper use of synthetic agricultural chemicals.

Since 1982, data from the Office of Agricultural Statistics (1992) indicated gradual yield reductions in major cash crops such as rice, Para rubber, cassava, corn and sugarcane. More recently in the 1988-91 cropping seasons, average rice yields unexpectedly declined by 54.8, 53.4 and 50.0 kg/ha, respectively. During the same period, the approximate consumption of imported agricultural chemicals, mainly fertilizers and pesticides, was increased at a rate of 200 percent. The overuse and improper use of these chemicals have caused considerable contamination of the soil, water and environment. The Land Development Department (1985) reported that the total amount of plant nutrients lost by runoff and leaching was about 27.4 million metric tons per year.

In addition, soil degradation throughout the country has increased as a result of excessive erosion. In a study of shifting cultivation on a 6-percent slope in the Northeast Region, Pairintra et al. (1982) reported a soil loss of 0.53 t/ha, whereas on a 9-percent slope in the Northern Highland area, the loss was as high as 4.17 t/ha (Chaisiri et al., 1983). Both agricultural and industrial sources have contributed significantly to soil and water pollution in Thailand. These pollutants have degraded the water quality in such rivers as the Chao Phraya (the main river of Thailand); dissolved oxygen (DO) has reached a critical level of 0.5 mg/l and the biological oxygen demand (BOD) has exceeded 200 mg/1. Very high levels of coliform bacteria have also been reported.

Intensive production of cash crops and poor management practices have caused severe soil erosion which has contributed to the degradation of soil quality, loss of productivity, and environmental pollution. Alternative agricultural management practices are urgently needed. One of the more promising methods, among holistic approaches, is Kyusei Nature Farming. The ultimate goals of Kyusei Nature Farming are to avoid the use of synthetic agricultural chemicals; to enhance environmental quality and protect natural resources; to improve productivity and profitability of farmers; to maintain long-term sustainability of farming systems; to optimize the use of on-farm resources and minimize the dependence of farmers on purchased inputs; and to enhance the safety and nutritional quality of food (Asia-Pacific Natural Agriculture Network, 1991).

Kyusei Nature Farming and APNAN Activities in Thailand

Kyusei Nature Farming was first introduced into Thailand in 1968 by a Sekai Kyusei Kyo missionary, Rev. Kazuo Wakugami, at Fang Agricultural Vocational School in Chiang Mai. In the beginning, there was little progress because of the need for large amounts of compost; the high incidence of plant diseases, insect infestations, and weeds; and low crop yields. In 1986, the school was moved to Sara Buri and its staff began to use Effective Microorganisms (EM) as a microbial inoculant to improve soil quality, enhance plant growth and increase crop yield. The effectiveness of EM was shown by improved crop and livestock production.

This achievement led Sekai Kyusei Kyo, the Thai Ministry of Agriculture and Cooperatives, the Green Esarn Project, and Khon Kaen University to hold the First International Conference on Kyusei Nature Farming at Khon Kaen University in October. 1989. At this meeting, the Asia-Pacific Natural Agriculture Network (APNAN) was established and a Steering Committee was formed with members from 13 Asian and Pacific countries. Details of the charter, objectives and activities are described in the APNAN Prospectus for 1990-91 and 1992-93, and also in the First Kyusei Nature Farming Conference Proceedings (APNAN, 1991).

Since its inception, APNAN has made much international progress. There have been three International Conferences on Kyusei Nature Farming held in Thailand (1989), Brazil (1991), and the United States (1993). Five Steering Committee Meetings have been held in Japan, Malaysia, Brazil, Sri Lanka and the United States. Two EM Technology Conferences and two Practical Training Sessions were held at the Kyusei Nature Farming Center at Sara Buri, Thailand.
APNAN has signed memoranda of “Exchange of Agreement” on the development of EM Technology with the Government of Myanmar, the State of Pondicherry in India, and the University of Agriculture at Faisalabad, Pakistan. The Government of Laos (Peoples Democratic Republic) and APNAN are now proposing to sign similar agreements. In addition, APNAN has invited other countries in the region to become APNAN members, i.e., New Zealand, China (PRC), Cambodia and Vietnam.

Research on EM Technology

Apart from international studies, APNAN members are now conducting EM experiments in their respective countries. In Thailand, some universities and agricultural experiment stations are conducting research on several aspects of Effective Microorganisms (EM) as follows. Verification of EM Stock Solutions The Faculty of Agriculture, Khon Kaen University, has studied the quality of imported EM stock solutions by culture and plate count techniques. Data in Table 1 show that the microbial populations are similar to those reported by Higa (1989). Furthermore, favorable results with EM 3 and EM 4 have been reported on plant growth response in both Japan and Thailand (Table 2).

Table 1. Numbers of Microorganisms in Stock Solutions of Effective Microorganisms (EM).

Stock Solution	Actinomycetes (CFU/ml)	Bacteria (CFU/ml)	Fungi (CFU/ml)
EM 2	1×10^3	4.3×10^7	1×10^2
EM 3	0	3.0×10^{11}	1×10^3
EM 4	0	9.0×10^8	1×10^4

source: Pairintra and Pakdee (1994)

Table 2. Effect of EM 3 and EM 4 on Growth of Plant Cuttings.

Country	EM	Initial Weight (g/cutting)	Final Weight (g/cutting)	Weight Gain (g/cutting)
Japan	3	96.8	132.4	35.6a
Thailand	3	123.5	156.1	32.6b
Japan	4	125.5	156.6	31.1b
Thailand	4	128.2	158.9	30.7b
Check		111.3	139.9	28.6c

Source: Pairintra et al. (1990)
Column means having the same letter are not significantly different from each other.

Compost

A study was conducted to compare two methods for making compost from water hyacinth, one recommended by the Department of Land Development and the other according to EM technology. The results indicate that the plant nutrient content (Table 3) and number of microorganisms (Table 4) were highest in the compost prepared with EM. An interesting observation was that in the process of composting, the EM compost maintained a lower temperature than the DLD compost. A possible explanation is that EM simulated the utilization of reserve organic energy under fermentation conditions without raising the temperature, which helped to prevent the release of intermediate products such as toxic wastes and gases. In addition, EM compost may be used within a relatively short period of time (Chaimahawan, 1992). Panchaban (1991) reported that agricultural wastes are the best materials for EM composting since they contain high levels of plant nutrients and low C:N ratios.

Other researchers have reported on the beneficial effects of EM compost for production of Para rubber (Photiwattutham et al., 1992); tea (Sudtoo, 1990) and strawberries (Jonglaekha et al., 1992). It should be noted that, in these studies, the applied EM compost had to meet the crops nutrient demands during the growth period.

Table 3. Quality of Water Hyacinth Compost Prepared by Two Treatment Methods.

Treatment	Total N (%)	C:N (ratio)	P_2O_5 (%)	K_2O (%)
Check	1.96	12.3b	0.73b	1.18
DLD-1	1.87	15.7a	0.36c	1.17
EM (1: 1000)	1.92	13.1b	0.83a	1.25

Source: Pairintra et al. (1990)
DLD-1: Composting method recommended by the Department of Land Development.
EM: Composting method according to EM technology.
The composts were analyzed after 15 days of incubation.
Column means having the same letter are not significantly different from each other.

Table 4. Numbers of Microorganisms in Water Hyacinth Compost Prepared by Two Treatment Methods.

Treatment	Actinomycetes (CFU/g)	Bacteria (CFU/g)	Fungi (CFU/g)
Check	1.7×10^{9}	1.5×10^{10}	2.6×10^{11}
DLD-1	8.2×10^{7}	1.3×10^{11}	4.2×10^{6}
EM (1:1000)	2.1×10^{9}	1.5×10^{11}	3.3×10^{6}

Source: Pairintra et al. (1990)
DLD-1: Composting method recommended by the Department of Land Development.
EM: Composting method according to EM technology.

Soil Improvement

A field study was conducted by Pairintra et al. (1990) to determine whether EM could help to restore the productivity of a degraded wasteland soil. EM was incorporated with a green manure in an intercropping system. Soil fertility was improved when the green manure was incorporated but declined again after harvest (Table 5). The results indicate that for highly degraded soils where the system is not yet stabilized, repeated applications of EM and an organic amendment must be made to ensure the survival and activity of the inoculated EM microorganisms (Pairintra et al., 1992a). The organic amendment helps to improve soil physical properties and also provides a carbon and energy source for the EM cultures.

Table 5. Biomass Production and Microbial Populations in Improved Wasteland Soil.

Crop Applied	EM	Biomass (kg/ha)	Bacteria (CFU/g x $l0^{9}$)	Fungi (CFU/g x $l0^{5}$)
Cassava	Yes	1837.2	4.05	3.07
Cassava-Sesame		1390.2	3.43	3.23
Cassava	No	2925.4	3.63	2.89
Cassava-Sesame		1544.4	3.37	2.53

Source: Pairintra et al. (1990)

Crop Production

Horticultural Crops. Experiments with EM applied to vegetable crops were conducted in pot and field trials in 1989-90 (Pairintra et al., 1990). The crops tested were: onion, green mustard, Chinese kale, sweet corn and papaya. The results showed that crop yields with EM solutions and EM compost were comparable to the yields obtained with recommended rates of chemical fertilizer. The highest yield obtained in the first cropping season was with the EM + chemical fertilizer treatment. However, in the second and third seasons EM alone produced the highest yields.

A study was conducted to compare the effects of EM, chemical fertilizer, and compost applications on the yield and quality of papaya. As shown in Table 6, the number of fruits per plant, fruit weight, and brix level (i.e., sugar content) were significantly higher with EM than the other treatments. A single exception was that the brix level due to compost was the same as for EM 2.

Table 6. Effect of EM Formulations, Chemical Fertilizer, and Compost on the Yield and Quality of Papaya.

Treatment	Yield (no./plant)	Yield (kg/fruit)	Brix Level (%)
Check	4.2c	1.2d	9.5b
Fertilizer	7.2b	1.8c	10.5b
Com post	6.0bc	1.8c	11.5a
EM 2	9.0a	2.4b	11.5a
EM 4	9.6a	3.0a	12.5a

Source: Pairintra et al. (1990)

Column means having the same letter are nor significantly different from each other.

Rice. A rice experiment was designed to run for two consecutive years under the guidelines of "Short- and Long-term Plans and Objectives of APNAN" (APNAN Newsletter, 1990). The treatments included chemical fertilizer, green manure, and compost applied with and without EM. The results presented in Table 7 show that rice yields and biomass production were consistently higher for both years when these treatments were applied with EM compared with no EM. EM plus green manure gave the greatest yield during the second year (Pairintra et al., 1992a). This is partly due to the slow release of nutrients from the EM fermentation-decomposition activity which is not harmful to the plant and is conceptually different from the oxidation-decomposition effect (Higa, 1989).

Table 7. Effect of Chemical Fertilizer, Green Manure, and Compost Applied with and without EM on Rice Yield and Biomass Production.

Treatment	EM Applied	Yield: First Yr. (kg/rai)	Yield: Second Yr. (kg/rai)	Biomass: Tops (g/hill)	Biomass: Roots (g/hill)
Check	No	288	380	5.9	5.6
Fertilizer	No	334	640	8.4	8.0
Green Manure	No	309	490	8.2	12.5
Compost	No	346	460	8.2	13.5
Check	Yes	243	560	6.5	5.8
Fertilizer	Yes	382	960	13.0	18.4
Green Manure	Yes	380	1140	16.8	26.1
Compost	Yes	361	1040	22.0	48.2

Source: Pairintra et al. (1992a)

Since rice is the major cash crop in most parts of the country, EM was also tested under different soil and climatic conditions. In acid sulfate soils of the Central Plain of Thailand, the results comparing EM and chemical fertilizers were inconclusive (Rungsichol et al., 1992). The poor soil properties may have been the primary problem as well as misinterpretation of the data. This was one of the problems encountered by Sekai Kyusei Kyo in terms of extending the data to the present.

Studies at the Northern Rice Research Center and Northern Highland Research Area by Boonyarit et al. (1990) indicated that EM combined with chemical or organic fertilizers gave the greatest yields of both transplanted (paddy) and broadcast (upland) rice. One of the studies indicated that the highest yields and lowest weed infestations occurred with the treatment combinations of organic and chemical fertilizer with EM (Table 8).

Table 8. Effect of Various Combinations of Chemical Fertilizers, Organic Amendments, and EM on Yield of Paddy Rice and Weed Populations 30 Days after Germination.

Treatment	Yield (kg/rai)	Weeds (no./2m^2)
Organic Fertilizer	236b	105a
Chemical Fertilizer	239b	114a
EM	240b	101a
Organic + Chemical Fertilizer	287a	112a
Chemical Fertilizer + EM	246b	112a
Organic Fertilizer + EM	252ab	104a
Organic Fertilizer + Chemical Fertilizer + EM	289a	106a
Check	114c	107a

Source: Boonyarit et al. (1990)
Column means having the same letter are not significantly different from each other.

Animal Production

Poultry Production. The effect of EM on the growth and body weight of broilers was determined. EM was thoroughly mixed with commercial feed and also with drinking water at a dilution of 1 : 1000. Table 9 shows that five-week old chickens treated with EM had significantly greater body weight than the control birds (Pairintra et al., 1992b). Moreover, it has been reported that some farmers have begun using EM with cattle and pigs; but documented research is not yet available.

Table 9. Effect of EM on the Body Weight of Broilers over Five Weeks.

Treatment	Weeks					Mean (g)
	1	2	3	4	5	
	(g)					
Control	158.3	358.9	680.3	1025.1	1134.5	671.4
EM 1	175.0	358.1	765.4	1145.4	1428.5	774.4
EM 2	166.5	350.5	687.1	1051.0	1350.5	721.1
EM 1 + EM 2	161.2	351.6	689.1	1051.6	1340.0	718.7

Source: Pairintra et al. (1992b)

Fish Production.

The efficacy of EM in the diet of catfish (*Clarias gariepnus*) was evaluated in cement tanks with artificial aeration. Thirty-five day-old fish were caught and weighed. The EM 4 treatment produced the greatest weight per fish at 1.1 kg. No transference of water occurred during the growth period and water remained clean; this was attributed to the effectiveness of the EM organisms in utilizing feed residues in the tank (Pairintra et al., 1992a). It has also been reported that some farmers in the Eastern Region have used EM successfully in shrimp aquaculture systems. Since almost all ponds were polluted and contaminated with agrichemicals, farmers saw this as an opportunity to evaluate EM.

Environmental Protection

Garbage Disposal. Research on garbage disposal is being studied by the Kyusei Nature Farming research staff. Quantity and quality analyses will be available in due course. Meanwhile, some municipalities have tried to suppress malodors with EM fermentation techniques.

Nutritional Value

Research studies comparing the nutritional value of conventionally-grown foods with those produced by nature farming methods is being conducted in collaboration with the Institute of Nutrition, Mahidol University (Banjong and Pairintra, 1993). Preliminary results indicate that vegetables produced by nature farming had a somewhat lower energy value (kcal/g), lower moisture content, and higher Vitamin C content than conventionally-grown produce. Additional research in this area is urgently needed.

Summary and Conclusions

EM Technology and its practical application as a microbial inoculant of beneficial microorganisms was introduced to Thailand only recently, i.e., within the past five years. Since then, it has shown great potential for improving soil quality; increasing crop growth, yield and quality; enhancing animal health and nutrition; and protecting the environment. Yet, there is an urgent need to conduct additional research (i.e., laboratory, greenhouse, field, and on-farm) to determine how best to use EM depending on agroecological conditions, soil type, climate, and cropping system. Experiments should be well-designed with treatments that are replicated and randomized with proper controls. This is the best way of establishing the scientific and technical credibility of EM, and instructing our farmers in its proper use for greater benefit.

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