EM Technology Application in Vietnam

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Abstract

Until 1997, EM technology becomes officially and widely applied in cultivation, animal husbandry and environment treatment. The Program of EM technology application in Vietnam implemented in 4 years, from 1997, with 3 main orientations:

Preparation of EM solution in Vietnam and supplying EM solution to the cities and provinces for using and testing.

Study, test and acceptance of EM technology.

Training and dissemination of EM technology.

Until now, EM technology has been applied in different extents and in different domains of cultivation, animal husbandry and environmental treatment in about 60% of Vietnam's cities and provinces. Some results of study of EM effects on crops and animal husbandry as following. Application of EM (in solution and bokashi) for rice, soya bean increased crop yield and shortened growth duration. EM could substitute for one fourth to one third quantity of chemical fertilizer without effecting yield. EM application in poultry and pig raising promoted growth and improved resistance, thereby increasing meat yield and shortening the raising period and consequently improving economic efficiency.

Introduction

Vietnam has got access to EM technology since 1994, 1995, through South Korea and China. But until April 1997, after the visit of Prof. Dr. Teruo Higa to Vietnam and the signature of memorandum of understanding between him and Prof. Dr. Chu Hao, Deputy Minister of Science, Technology and Environment, this technology becomes officially and widely applied in cultivation, animal husbandry and environment treatment. The Ministry of Science, Technology and Environment has decided to carry out an independent national scientific thesis: ''Study, test and acceptance of EM technology in agriculture and environmental sanitation'' from January 1998 to December 2000.

Seven institutions have involved in this research project, i.e. Hanoi Agriculture University, Hanoi National University, Vina-Nichi Center for Technology Development, Hanoi Agriculture Science and Technique Institute, National Institute of Plant Protection, Veterinary Institute and Chemical Industry Institute.
Until now, the thesis has brought about a lot of good results.
The present report will focus in presenting some initial results of using EM for cultivation and animal husbandry.

1. The general situation of EM technology application in Vietnam

The Program of EM technology application in Vietnam implemented in 4 years, from 1997 with 3 main orientations for using and testing.

Preparation of EM in Vietnam and supplying EM solution to the cities and provinces.

Study, test and dissemination of EM technology.

Training and dissemination of EM technology.

While the implementation of the program, since 1997 until now, the Vietnam side has received extremely valuable assistance from APNAN, EMRO and INFRC Japanese organizations.
Thank to this assistance, the Vietnam side has promoted the application of EM technology in different domains of agricultural production and environmental protection.
Until now, EM technology has been applied in different extents and in different domains of cultivation, animal husbandry and environmental treatment in about 60% of Vietnam's and cities and provinces. The localities where EM technology has been applied are marked in the attached map (fig.1).

Map:

With the assistance of APNAN, EM product has been prepared in Vietnam since August1997. Until now, over 25 tons of EM1 have been used, of which about 50% is used for environmental treatment, 34% for research and16% for other purposes.

2. In the period 1/1998 - 12/2000, The Ministry of Science, Technology and Environment allowed to carry out a study thesis of national level "Study, test and acceptance of EM technology in agricultural and environmental sanitation." The thesis is monitored by the Hanoi Agricultural University No.1 with the participation and collaboration of 6 other institutions, namely:

* Hanoi National University, within the Ministry of Education and Training.
* Hanoi Institute of Agricultural Science and Technique, within the Ministry of Agriculture and Rural Development.
* Institute of Plant Protection, within the Ministry of Agriculture and Rural Development.
* Institute of Veterinary, within the Ministry of Agriculture and Rural Development.
* Institute of Industrial Chemistry, within the Ministry of Industry.
* Vina-Nichi Center for Technology Development, within the Ministry of Science, Technology and Environment.

18 experiments have been conducted with the following contents:

Study of main species of microorganisms in EM product

Study of application of EM in environmental protection

Study of EM effects on crops

Study of EM influence on pests and disease of crops

Study of EM influence on animal husbandry and veterinary

Results of experiments have showed positive effects of EM on crops, domestic animals and environment.

The following are some results in studies of EM effect on crops and domestic animals.

2. EM effects on crops
2.1. Rice

The trial for studying EM effects on rice has been carried out in the experimental field of Hanoi Agricultural University No.1. The experiments were reiterated many times in two different seasonal crops of 1998 and 1999, the first seasonal crop and the second seasonal crop.

Contents of studies

Using EM Bokashi to replace Farm Yard Manure (FYM) and inorganic fertilizers;

Identifying the effective combination of inorganic fertilizers, Bokashi and spraying EM.

Identifying the economic efficiency of EM in rice cultivation.

Materials and study methods

The rice variety used in the experiments is CR203, with 3 times reiteration on experimental plots of 20 sq.m. each.

In 1998:

Experiment No. 1: Study of effect of EM sprayed on rice.

T1: 6T FYM/ha + NPK 100:60:40 kg/ha
T2: 6T FYM/ha + NPK 50:30:20 kg/ha + EM (61/ha)
T3: 6T FYM/ha + EM (61/ha)

Experiment No. 2: Study of effect of EM sprayed and EM Bokashi.

T1: 10T FYM/ha + NPK (control)
T2: 10T FYM/ha + NPK + spray EM
T3: 1T Bokashi/ha + NPK
T4: 2T Bokashi/ha + NPK
T5: 3T Bokashi/ha + NPK
T6: 1T Bokashi/ha + NPK + spray EM
T7: 2T Bokashi/ha + NPK + spray EM
T8: 3T Bokashi/ha + NPK + spray EM

NPK fertilizers used for all treatments (120 kg Nitrogenous fertilizer + 90 kg Super phosphate + 90 kg Kaliclorua)/ha.

In 1999:

In the first crop, the experiments were conducted as follows:

T1: Without fertilizer (control)
T2: 8tons FYM/ha
T3: 8tons FYM/ha + NPK 80:70:30 kg/ha
T4: 8tons FYM/ha + NPK 40:35:15 kg/ha + spray EM
T5: 8tons FYM/ha + spray EM
T6: 2tons Bokashi + NPK 80:70:30 kg/ha
T7: 2tons Bokashi + NPK 40:35:15

kg/ha + spray EM

T8: 2tons Bokashi + spray EM

In the second crop, the experiments were conducted as follows:

T1: Without fertilizer (control)

T2: 8tons FYM/ha

T3: 8tons FYM/ha + NPK 80:70:30 kg/ha

T4: 2tons Bokashi/ha

T5: 8tons FYM/ha + NPK 40:35:15 kg/ha + spray EM

T6: 8tons FYM/ha + NPK 53.3:46.6:10 kg/ha + spray EM

T7: 2tons Bokashi/ha + NPK 80:70:30 kg/ha + spray EM

T8: 2tons Bokashi/ha + NPK 40:35:15 kg/ha + spray EM

T9: 2tons Bokashi/ha + NPK 53.3:46.6:10 kg/ha + spray EM

T10: 8tons FYM/ha + NPK 80:70:30 kg/ha + spray EM

T11: 2tons Bokashi + spray EM

Results and Discussions

The influence of spraying EM on the growth development and yield of rice variety CR203 is showed in Table 1.

Table 1. The Effects of EM on Growth, Development and Yield of CR203 Variety

Harvest	Treatment	Height of seedling	Height of plant	Effective clums/plant	Effective grains/head	Weight of 1000 grains	50% flowering time	Yield (t/h)
1	6T FYM + NPK 100:60:40 kg/ha	26.5	89.0	4.1	96	24.0	99	4.20
2	6T FYM + NPK 50:30:20 kg/ha + EM	26.5	88.3	4.5	112	24.8	94	4.42
3	6T FYM + EM	26.5	89.3	3.8	110	24.2	90	4.45
4	LSD (5%)			0.68				0.115
1	6T FYM + NPK 100:60:40 kg/ha	27.0	94.5	4.65	96	23.5	93	3.92
2	6T FYM + NPK 50:30:20 kg/ha + EM	27.0	92.6	5.20	112	23.7	88	4.41
3	6T FYM + EM	27.0	93.4	5.22	110	23.9	80	4.21
4	LSD (5%)			0.45				0.46

The comparison of economic efficiency of spraying EM for the second rice is showed in Table 2.

Table 2. Economical Efficiency of EM on CR203 Variety

Treatment	Yield t/ha	Income (10^6 VND)	Expense (10^6 VND)			Profit (10^6 VND)
			Output	Labor	Materials	
6T FYM + NPK 100:60:40 kg/ha	3.92	7.056	5.20	3.24	1.96	1.856
6T FYM + NPK 50:30:20 kg/ha + EM	4.41	7.938	5.55	3.55	1.97	2.388
6T FYM + EM	4.21	7.578	4.31	3.51	0.08	3.263

The results of experiments of combination of EM Bokashi, FYM and spraying EM Bokashi with the rice variety C70 are showed in Table 3.

Table 3. The Effects of EM on Yield and Grain Quality of C70 Variety

Treatment	Greenhouse plots (1 m^2)				In the field		Grain quality		
	Theoretical yield		Attained yield		Attained yield				
	x100 kg/ha	% compared with control	x100 kg/ha	% compared with control	x100 kg/ha	% compare with control	% Dry matter	% protein	% starch
10T FYM + NPK (control)	68.6	100.0	52.3	100.0	54.8	100.0	90.71	5.58	59.80
10T FYM + NPK + spray EM	83.6	105.7	54.1	103.0	55.9	102.0	91.23	5.83	60.22
1T Bokashi + NPK	67.5	98.4	51.6	98.7	53.7	98.0	91.14	5.82	59.54
2T Bokashi + NPK	75.1	109.5	55.2	105.5	58.6	106.9	91.51	5.90	60.91
3T Bokashi + NPK	82.5	120.3	59.4	113.6	60.8	110.9	91.72	6.00	61.53
1T Bokashi + NPK + spray EM	79.1	115.5	57.3	109.6	59.0	107.7	91.53	5.90	60.30
2T Bokashi + NPK + spray EM	85.4	124.5	60.8	116.3	63.3	115.5	92.83	6.03	61.84
3T Bokashi + NPK + spray EM	88.3	128.7	62.0	118.5	65.2	119.0	92.88	6.06	62.86
LSD (5%)			1.16		2.1				

Throughout Tables 1, 2 and 3, we can use:

The use of EM has good influence not only on the growth, development and yield of rice, but also on the quality of rice. In the rice variety CR203, especially in the second crop of1998, the rice yield increased by 290 - 490 kg/ha (or 8.0 - 15.5%) compared with the control. EM has also a good effect on the quality of rice: the content of protein increases from 0.42% to and the content of starch increases from 0.42% to 3.06%.

The use of EM may reduce the quantity of inorganic fertilizer or FYM, and the yield is ensured.

The use of EM may reduce the development cycle of rice by 5 - 13 days, especially in the summer-autumn crop.

Table 3 shows that the application of 2 tons of EM Bokashi/ha in combination with spraying EM may lead to results.

Table 4. The Effect of EM on Growth, Development and Yield of CR203 Variety of Two Harvests in 1999

No.	Treatment	Plant height (cm)	Culms length (cm)	Culms/plant	Grains/head	1000 grains (g)	yield x100 kg/ha
1	Without fertilizer (control)	80.0	21.0	3.6	97	22.8	29.80
2	8T FYM/ha	85.0	21.4	4.2	106	23.3	37.6
3	8T FYM + NPK 80:70:30 kg/h	92.5	21.7	5.3	113	23.4	48.50
4	8T FYM + NPK 40:35:15 kg/ha + EM	88.9	21.6	5.1	110	23.7	46.80
5	8T FYM + EM	86.0	21.5	4.7	108	23.4	38.50
6	2T Bokashi + NPK 80:70:30 kg/ha	92.5	21.7	5.0	110	23.6	47.60
7	2T Bokashi + NPK 40:35:15 kg/ha + EM	91.2	21.5	4.8	110	23.4	43.50
8	2T Bokashi + EM	87.3	21.4	4.6	108	23.4	39.0
	CV%						4.8
	LSD 5%						0.69
	LSD 1%						0.96
1	Without fertilizer (control)	80.1	17.7	5.0	84	22.4	30.20
2	8T FYM/ha	83.0	20.0	6.4	90	23.0	35.60
3	8T FYM + NPK 80:70:30 kg/ha	92.5	21.3	8.0	102	23.2	48.10
4	2T Bokashi/ha	83.0	20.3	6.4	94	23.2	36.10
5	8T FYM + NPK 53.3:46.6:10 kg/ha + EM	91.7	20.6	7.0	99	23.4	46.20

6	8T FYM + NPK 53.3:46.610 kg/ha + EM	94.5	20.8	8.0	100	23.4	49.30
7	2T Bokashi + NPK 80:70:30 kg/ha + EM	95.5	21.3	8.1	101	23.8	51.60
8	2T Bokashi + NPK 40:35:15 kg/ha + EM	91.9	20.8	7.0	97	23.5	46.10
9	2T Bokashi + NPK 53.3:46.6:10 kg/ha + EM	91.6	21.0	7.7	102	23.5	49.80
10	8T FYM + NPK 80:70:30 kg/ha + EM	95.4	21.3	8.2	105	23.6	55.0
11	2T Bokashi + EM	85.5	20.2	6.5	92	23.5	39.0
	CV %						7.1
	LSD 5%						1.07
	LSD 1%						1.46

From Table 4, we can see that:

All experimental formulae give a higher yield compared with the control.

In the first crop of the year, the formula No. 3 gives highest yield, then followed by the formula No. 6. The yield of these 2 formulas is equal to the other because of no difference of 5% significance in Duncan comparison.

In the second crop of the year, the formulae No.10 give highest yield.

In these 2 formulas, the same quantity of NPK fertilizer is applied and EM is sprayed; the difference is that in a formula 2 tons of bokashi is applied (manure is fermented by EM), and in the other formula 8 tons of manure is applied. Thus, 2 tons bokashi may replace 8 tons of manure for ensuring a high yield.

Table 4 also shows that EM Bokashi may replace manure and spraying EM may reduce manure and chemical fertilizer and ensure similar yield. The comparison efficiency of EM applied for 2 crops of1999 is shown in Table 5 and Table 6.

Table 5. Economical Efficiency in the First harvest of the Year 1999 ($x10^6$VND/ha)

No.	Treatment	Total income	Total expense	Profit
1	Without fertilizer (control)	6.36	4.969	1.391
2	8T FYM/ha	7.52	6.169	1.351
3	8T FYM + NPK 80:70:30 kg/ha	9.70	7.127	2.579
4	8T FYM + NPK 40:35:15 kg/ha + EM	9.36	6.988	2.372
5	8T FYM + EM	7.70	6.509	1.191
6	2T Bokashi + NPK 40:35:15 kg/ha	9.52	6.527	2.993
7	2T Bokashi + NPK 40:35:15 kg/ha + EM	8.70	6.377	2.323
8	2T Bokashi + EM	7.80	5.909	1.898

Table 5 shows that 2 tons of bokashi instead 8 tons of manure (formula No. 6 and formula No. 3) may lead to a higher economic efficiency.

Table 6. Economical Efficiency in the Second Harvest of the Year 1999 ($x10^6$VND/ha)

No.	Treatment	Total income	Total expense	Profit
1	Without fertilizer (control)	6.040	4.696	1.071
2	8T FYM/ha	7.120	6.169	0.951
3	8T FYM + NPK 80:70:30 kg/ha	9.620	7.127	2.493
4	2T Bokashi/ha	7.300	5.569	1.731
5	8T FYM + NPK 40:35:15 kg/ha + EM	9.240	6.988	2.252
6	8T FYM + NPK 53.3:46.6:10 kg/ha + EM	9.860	6.072	2.788
7	2T Bokashi + NPK 80:70:30 kg/ha + EM	10.320	6.867	3.453
8	2T Bokashi + NPK 40:35:15 kg/ha + EM	9.220	6.388	2.832

From Table 6, we can see that the reduction of manure and the use of bokashi instead and the reduction of chemical fertilizer and spraying EM instead, the economic efficiency increases obviously. This is shown in the formulae No.s10 and 3, and the formula No. 9 and No. 3.

Conclusions

From the results of experiments of using EM for rice crop, the following conclusions may be drawn:

EM has a good effect on the growth, development and yield of rice varieties CR203 and C70 in Vietnam.

The use of EM may reduce the quantity of inorganic fertilizers (a reduction of 3/4 of manure) while ensuring the yield.

The use of EM may shorten the rice vegetation on cycle by 5 - 13 days. This has a particular significance on the carrying out of winter crop.

The use of EM may restrict pests and diseases, especially the disease of yellow leaf.

2.2. EM applied for soya bean

The experiments for studying the effect of EM on the development, growth and yield of soya bean have been carried out as follows:

2.2.1. Formula of experiments

T1: 8T FYM/ha + NPK 50:150:100 kg/ha

T2: 8T FYM/ha + NPK 25:75:50 kg/ha + spray EM

T3: 2T Bokashi + NPK 25:75:50 kg/ha

T4: 3T Bokashi + NPK 25:75:50 kg/ha

T5: 1T Bokashi + NPK 25:75:50 kg/ha + spray EM

T6: 2T Bokashi + NPK 25:75:50 kg/ha + spray EM

Bokashi is produced from FYM, rice bran, rice husk with the proportion of 2:1:1.

The secondary EM is diluted with the proportion of 1/1000, sprayed with a quantity of 400 - 500 liters/ha at 4 times: at the stage of 3 - 4 leaves, starting of flowering, profuse and vigorous blossom, completion of flowering.

EM Bokashi animal manure and inorganic fertilizer are applied at sowing time.

2.2.2. Results and discussions

The effect of EM on the growth, development and yield of the soya bean variety DT84 in Vietnam is showed in Table 7.

Table 7. The Effect of EM on Growth, Development and Yield of Soy Bean DT84.

No.	Treatment	Plant height (cm)	Leaves/plant	Yield 100 kg/ha	Attained yield 100 kg/ha	% comparison
1	8T FYM + NPK 50:150:100 kg/ha	44.8	9.5	32.4	27.8	100.0
2	8T FYM + NPK 25:75:50 kg/ha + EM	44.9	9.9	40.5	30.1	110.8
3	2T Bokashi + NPK 25:75:50 kg/ha	44.6	10.2	42.6	30.7	111.5
4	3T Bokashi + NPK 25:75:50 kg/ha	45.2	10.5	44.6	31.8	114.3
5	1T Bokashi + NPK 25:75:50 kg/ha + EM	45.4	10.6	44.8	32.3	116.1
6	2T Bokashi + NPK 25:75:5 kg/ha + EM	46.0	10.9	45.7	33.1	119.3
	LSD (5%)	0.5		1.8	1.03	

EM (EM Bokashi and spraying EM) has an obvious effect on the growth and development of soya bean; the yield of soya bean in all experimental formula is 10 - 19% higher than the control; the best results are got from the formula No. 5 and the formula No. 6 where 1 ton and 2 tons of bokashi and spraying EM are applied, respectively.

Analysis of quality of soya bean grain (see Table 8):

Table 8. The Effect of EM on Grain Quality of Soy Bean DT84 in Vietnam.

No.	Treatment	Dry matter %	Ashes %	Lipid %	Comparison %	Protein %	Comparison %
1	8T FYM + NPK 50:150:100 kg/ha	93.50	4.83	21.5	100.0	24.15	100.0
2	8T FYM + NPK 25:75:50 kg/ha + EM	94.60	5.41	21.7	100.9	26.43	109.0
3	2T Bokashi + NPK 25:75:50 kg/ha	93.94	5.26	21.6	101.8	26.49	109.7
4	3T Bokashi + NPK 25:75:50 kg/ha	94.60	6.21	23.0	106.7	28.29	117.1
5	1T Bokashi + NPK 25:75:50 kg/ha + EM	94.45	6.30	22.7	105.6	28.94	119.8
6	2T Bokashi + NPK 25:75:50 kg/ha + EM	94.62	6.80	23.2	107.9	29.35	121.5

From Table 8 we can see that, under the effect of EM, the quality of soya bean grain is much improved; the content of mineral matters, lipid, crude protein is obviously higher than the control.
From the aspect of economic efficiency, the use of EM Bokashi and spraying EM gives higher profit; the profit may reach 3,041,000 VND/ha - 3,321,000 VND/ha).

2.2.3. Conclusions

The use of EM has a good effect on the growth and development of soya bean in Vietnam, hence a higher yield and a better grain quality compared with the control (without using EM).

The application of 1 ton of bokashi and 2 tons of bokashi in combination with spraying EM in 4 stages (germination, branching, flowering and fruiting) may lead to the highest yield.

The use of EM gives a higher economic efficiency than without use of EM application.

3. Studies of EM effects on animal husbandry

3.1. Pigs

The experiments have been conducted in the Hanoi Agricultural University, on 10 head of pigs for meat from weaning to slaughtering age. Pigs are divided into 2 groups, a group with EM fermented feed (as experiment) and a group for which the feed is not fermented with EM (as control).

5 head are fed with EM fermented feed.

5 head are fed with normal feed (control).

The growth of body weight is an important index in keeping pigs for meat.
The results of accumulate weight in different months of pigs are showed in Table 9.

Table 9. Accumulate Weight Increasing of Pigs (kg/pig)

Treatment	Control (n=5)			Experiment (n=5)			Comparison	P
	x ±mx	Sx	CV%	x ±mx	Sx	CV%		
Start	14.10 ±0.67	1.34	9.52	14.04 ±0.99	1.98	14.13		
1st month	19.00 ±0.58	1.15	5.81	22.40 ±2.31	4.63	20.66	113.13	***
2nd month	27.80 ±1.78	3.56	12.82	33.30 ±3.76	7.53	22.61	116.91	***
3rd month	38.00 ±3.76	7.35	19.34	41.80 ±4.22	8.44	20.19	110.00	***
4th month	54.10 ±4.15	8.31	15.36	56.80 ±6.50	13.01	22.90	105.00	***
Average							111.26	

Note. ***Difference of $P < 0.001$

From Table 9, we can see that:

The body weight of pigs increases from month to month in conformity with natural laws of animal's growth and development.

The accumulate weight of experimental pigs is 105% - 116.91% higher than control.

3.2. Chicken

Experiments have been made with 210 chickens for meat. Chickens are divided into 3 groups:

Group 1:70 head is fed with normal feed and drinks clean water.

Group 2:70 head is fed with normal feed and drinks water added with EM1 of 1/1000.

Group 3:70 head is fed with feed added with EM Bokashi of 1% proportion and drinks water added with EM1 of 1/1000 proportion.

The results of the weight of chicken are shown in Table 10.

Table 10. The Weight of Experimental Chickens (g/chicken)

Age (week)	Weight (g/chicken)			Relative value comparison		
	T1 (n = 70)	T2 (n = 70)	T3 (n = 70)	T1	T2	T3
0	37.95a	37.41a	37.01a	100.00	100.00	100.00
1	135.04a	135.18	135.03	100.00	100.00	100.00
2	340.49b	351.13ab	360.36a	100.00	103.12	105.84
3	670.47c	697.70b	725.62a	100.00	104.06	108.23
4	1057.44c	1104.68b	1159.69a	100.00	104.47	109.67
5	1558.36c	1630.59b	1713.95a	100.00	104.64	109.98
6	2043.60c	2142.71b	2259.95a	100.00	104.85	110.31
7	2513.16c	2645.73b	2772.30a	100.00	105.26	110.31
			2792.30a			

Group 1: normal feed and drinking water (control).
Group 2: drinking water added with 0.1% of EM1.
Group 3: feed added with bokashi and drinking water added with 0.1% of EM1.

Table 10 shows that:

The use of EM1 in drinking water and bokashi in feed may improve the growth and development of chicken. Thus, the use of EM in raising pigs for meat and chicken for meat may lead to similar results as follows:

Pigs and chicken grow and develop better.

EM may increase the capacity of feed consumption of animals, improve animal's health and strength, increase the economic efficiency of animal husbandry.

EM may improve environment (less stink, less flies).

Some indexes such as physiobiology and biochemistry of blood, quality of meat of experimental animals are improved.

4. Conclusions

Thanks to the support of the Ministry of Science, Technology and Environment and the assistance of APNAN, EMRO, INFRC organizations of Japan, the EM technological program in Vietnam has been successfully implemented.

From 1997 until now, EM technology has been tested and applied in a scientific manner in different domains; reliable data related to the effects of EM on crops, domestic animals and environmental treatment have been obtained.

On such basis, EM technology will be widely applied in Vietnam for contributing to ensure the sustainable development of the country's agriculture, increase the yield and quality of crops and domestic animals, improve the effect of environmental treatment, reduce pollution and improve environment.