Research and Development of Effective Microorganism (EM) Technology in Myanmar

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_. Introduction

By virtue of tremendous potential in land, water and human resources for crop production, Myanmar has traditionally been existing as agricultural country with core agriculture sector which accelerate the economic development of the state. A variety of crops are being successfully cultivated to make domestic food security in accord with increasing population on the one hand and to achieve surplus for export earning on the other. In addition, Myanma Agriculture Service (MAS), under the guidance of Ministry of Agriculture and Irrigation (MOAI) has been implementing for the improvement of major crop production through area expansion and increase per unit productivity. Moreover, great efforts are being made to produce quality crops and to establish nature farming at some areas in the country aiming towards for attaining sustainable crop production as well as environment friendly production practices.

Myanmar was initiated to use EM solution by testing its effectiveness on several crops yield throughout the country after becoming a member of Asia Pacific Natural Agriculture Network (APNAN) in 1990. After having in technical collaborative agreement with APNAN, Thailand and International Nature Farming Research Centre (INFRC), Japan, pilot EM production units have been established at Central Agriculture Research and Training Centre (CARTC), Hlegu in 1993 and at Yedashe sugar mill in 1996 with the objective of producing EM solution to meet the users' demand. Since then, adequate amount of EM solution have been producing in accord with local demand.

_. Studies on the effect of EM

_.1. Results of on-station trials:

The experiments with rice, chickpea and mungbean were conducted at Central Agriculture Research Institute (CARI), Yezin in 1995 through 1998 with the objective of investigating crops yields, disease infestation and some physical and chemical properties of soil as affected by the EM.

Table-1. Rice grain yield of EM experiment, conducted at Agri. Chem. Div. during 1995, wet season with Manawthukha variety. (4 _10 RCB)

Sr.No.	Treatment	Yield (kg/ha)
1	Urea $_{125\ kg/ha}$ + TSP $_{63\ kg/ha}$ + MOP $_{31\ kg/ha}$	5343
2	Tr.(1) + EM solution 148 l/ha	5616
3	Tr.(1) + Bokashi 2.5 t/ha	5203
4	Tr.(1) + Compost 2.5 t/ha	4843
	F. test	**NS**
	C.V%	**16.2**

This experiment consisting of four treatments with 10 replications, was conducted at CARI, Yezin. Rice grain yields are not significantly different among NPK with or without either EM solution or Bokashi.

Table -2. Rice grain yield of EM experiment, conducted at Agri. Chem. Div. during 1995, wet season with Theehtatyin variety. (4 _7 RCB)

Sr.No.	Treatment	Yield (kg/ha)
1	Control	2425
2	EM solution 148 l/ha	2374
3	Bokashi 2.5 t/ha	2286
4	Compost 2.5 t/ha	2642
	F. test	**NS**
	C.V%	**22.7**

This experiment was carried out on 6__3_ brick-tank in which no chemical fertilizers were applied in order to clarify the effectiveness of EM on rice crop. EM inoculated compost (Bokashi) did not increase rice yield over ordinary compost while no yield difference was observed between control and EM 148 l/ha.

Table-3. Mean rice grain yield from EM experiment, conducted at Agri. Chem. Div. during 1996 to 1998 with Manawthukha variety. (6 _3 RCB)

Sr.No.	Treatment	Yield (kg/ha)
1	Control	3090 ^{cd}
2	Urea $_{63\ kg/ha}$ + TSP $_{63\ kg/ha}$ + MOP $_{31\ kg/ha}$	3605 ^{ab}
3	Urea $_{126\ kg/ha}$ + TSP $_{63\ kg/ha}$ + MOP $_{31\ kg/ha}$	3656 ^{ab}
4	EM solution 148 l/ha	2781 ^{d}
5	Tr.(2) + EM solution 148 l/ha	3502 ^{bc}
6	Tr.(3) + EM solution 148 l/ha	4017 ^{a}
	F. test	*** ***
	C.V%	**7.98**

Above data are from on-station EM experiment conducted during 1996 through 1998 and pooled analysis of grain yields are shown in table 3. No rice yield increases were noted due to EM solution as compared to control plot. Furthermore, rice grain yield did not responded to added EM at both rates of N as Urea 63 kg/ha and Urea 126 kg/ha.

Soil samples from the experimental site at CARI, before land preparation and after conducting for 3 successive years at same site, were collected and some analysis were done in order to observe the changes of physical and chemical properties of soils as affected by EM. No influences on changes of soil properties were found so far by the application of EM addition until after 3 successive years. (table 4).

Table 4. Some properties of soils before and after EM experiment, Yezin.

Treatment	p^H	Available			C.E.C m.e/100 g	Exchangeable			O.M%	Water Soluble SO_4%	Texture Class
		N%	P_2O_5 (kg/ha)	K_2O%		Ca	Mg	Na			
Before Experiment	5.00	0.0049	52.65	0.0182	7.82	5.60	1.58	0.20	0.05	**Nil**	**Sandy** loam
After 3 years											
1.conrol	4.84	0.0071	26.76	0.0050	6.05	3.88	0.83	0.05	0.93	Nil	**Sandy** loam
2.U_{63}+TSP_{63}+MOP_{31}	5.00	0.0048	19.07	0.0092	6.49	3.79	1.19	0.04	0.93	Nil	**Sandy** loam
3.U_{126}+TSP_{63}+MOP_{31}	4.85	0.0047	19.08	0.0064	5.30	3.88	0.79	0.03	0.75	Nil	**Sandy** loam
4.EM solution 148 l/ha	4.84	0.0050	12.41	0.0079	4.83	2.63	0.78	0.05	0.75	Nil	**Sandy** loam
5.trt.(2)+EM 148 l/ha	4.82	0.0057	14.46	0.0068	2.21	2.61	0.64	0.04	0.64	Nil	**Sandy** loam
6.trt.(3)+EM 148 l/ha	5.00	0.0030	19.84	0.0053	4.08	2.11	0.48	0.03	0.64	Nil	**Sandy** loam

Table-5. Mean rice grain yield and BLB incidence as affected by EM, conducted at Plant Pathology Div. during 1996 through 1998 with Yadanar Aung variety. (6 _3 RCB)

Sr.No.	Treatment	Yield (kg/ha)	BLB* Severity score
1	Control	1653	1.30
2	Urea $_{63\ kg/ha}$ + TSP $_{63\ kg/ha}$ + MOP $_{31\ kg/ha}$	2508	1.02
3	Urea $_{126\ kg/ha}$ + TSP $_{63\ kg/ha}$ + MOP $_{31\ kg/ha}$	2493	1.53
4	EM solution 148 l/ha	1581	1.20
5	Tr.(2) + EM solution 148 l/ha	2168	1.30
6	Tr.(3) + EM solution 148 l/ha	2559	1.03
	F. test	**NS**	-
	C.V%	**25.89**	

* Bacterial Leaf Blight (BLB) Severity Scoring were followed as described in Standard Evaluation System for rice (IRRI).

Three years data were worked out into pooled analysis of variance and disease scoring for BLB was also done to evaluate the effect of EM on grain yield and rice diseases. No differences in rice grain yield were found in treatments with EM added to either control or both level of Urea. In addition, there were more or less the same in BLB severity across the treatments tested including EM spray. (table-5).

Chickpea:

Table-6. Seed yield and severity of Botrytic gray-mould (BGM) disease of chickpea from EM experiment, conducted at Plant Pathology Div., Yezin in 1997 (Late monsoon) with ICC-86111 variety. (6 _3 RCB)

Sr.No.	Treatment	Seed Yield (kg/ha)	BGM* Severity score
1	Control	180.83 [b]	4.00
2	Urea $_{31\ kg/ha}$ + TSP $_{94\ kg/ha}$ + MOP $_{31\ kg/ha}$	271.25 [ab]	3.67
3	EM solution 148 l/ha	267.38 [ab]	3.67
4	Rhizobium + TSP $_{94\ kg/ha}$ + MOP $_{31\ kg/ha}$	254.25 [b]	4.00
5	Tr.(2) + EM solution 148 l/ha	249.61 [b]	4.00
6	**Tr.(4) + EM solution 148 l/ha**	367.85 [a]	4.00
	F. test	**	-
	C.V%	**27.04**	

According to the results from EM experiment with chickpea, seed yield did not found to be responded to EM solution alone and combination of EM with Urea, TSP and MOP. However, yield increases as much as 44% was achieved by the addition of EM solution to the treatment of Rhizobium with TSP and MOP fertilizers. On the contrary, since Botrytic Gray Mould (BGM) severity was very similar among the treatments, no influence on chickpea BGM disease was observed on account of EM applied.

Mungbean:

Table-7. Mungbean seed yield and incidence of Cercospora leaf spot from EM experiment, conducted at Plant Pathology Div., Yezin during 1996 and 1997 (pre- monsoon) with Yezin-1 and sample 1-B varieties. (6 _3 RCB)

Sr. No.	Treatment	1996, Yezin-1		1997, Sample 1-B	
		Yield (kg/ha)	Cercospora Severity score	Yield (kg/ha)	Cercospora Severity score
1	Control	693.31	6.4	1226.53 [b]	5.0
2	Urea $_{31}$ + TSP $_{94}$ + MOP $_{31\ kg/ha}$	871.72	6.1	1245.88 [b]	5.0
3	EM solution 148 l/ha	774.95	5.8	1291.05 [b]	5.0
4	Rhizobium + TSP $_{94}$ + MOP $_{31\ kg/ha}$	839.46	5.7	1487.00 [ab]	5.0
5	Tr.(2) + EM solution 148 l/ha	840.26	5.6	1499.10 [ab]	5.0
6	**Tr.(4) + EM solution 148 l/ha**	811.23	5.6	1750.69 [a]	5.0
	F. test	**NS**	-	**	-
	C.V%	**21.4**		**9.08**	

As carried out in both 1996 and 1997, pre-monsoon season with mungbean, no apparent seed yield increases were observed through the EM addition to either control or both N,P,K and Rhizobium with P,K treatments. In addition incidence of Cercospora leaf spot were found to be the same comparing between treatments with and without EM.

_.2. Findings of some on-farm trials:

A lot of on-farm trials were extensively carried out as farmers' participatory approach in 1993 to 1995 across the country to clarify the effectiveness of EM.

In Mandalay division, rice yield increases as much as 250-500 kg/ha was reported through two successive years application of EM solution in some trials.

Majority of the trials, conducted in Ayeyawady division produced more rice yield by 8-38% due to EM addition against the control plots while some trials were not responded to EM.

The results from EM on-farm trials carried out in Mon state during 1994 wet season demonstrated that EM addition to some rice field increases rice yields ranging 500-1000 kg/ha. However, no effect on rice grain yield due to the utilization of EM solution was reported by the Bago division according to the finding of EM on-farm trials conducted in 3 townships during 1994 wet season.

All findings of on-farm trial results, conducted in several locations during 1993 to 1995, were very inconsistently responded to addition of EM solution alone. It is probably due to the initially lack of technology known-how concerning EM technology. In addition, EM itself is living things and its multiplication and effectiveness are perhaps dependent on unknown several factors. So it might take certain times to find positively and consistantly crops yield increases as affected by EM.

In general, no denial about the common findings of on-farm trials conducted in different states and divisions during 1993 to 1995 are as follows:

- Hand weeding is much easier probably, because of physical improvement of soils.
- Still-green effect is noticeably elaborated at ripening stage.
- Enhances early recovery of transplanted rice seedlings and better plant vigor.
- Enhance early maturity.
- Relatively mitigate the incidence of Bacterial Leaf Blight (BLB) and rice gall midge.

Furthermore, effects of EM on various crops yield comparing that of FYM and chemical fertilizers were also tested in 1997.

The results of 4 simple trials carried out in each 4 divisions, viz: Bago, Yangon, Ayeyarwady and Mandalay divisions revealed that EM has relatively positive contribution to increase rice yields.

Maize yields as affected by EM conducted in Lewe townships in 1997 with Suwan-3 variety were out yielded over control plot whereas, yields were more or less the same between EM and fertilizer treated plots.

Studies on the effect of EM were also implemented with Radish and Muskmelon at vegetable and Fruit Research and Development Centre (VFRDC), Hlegu in 1997. Marketable yields of radish (t/ha) were found to be increased on account of EM addition while EM inoculated compost (Bokashi) gave higher marketable fruit yields of muskmelon as much as 5 t/ha against the FYM plots. A side from the effect on fruit yields, earlier in maturity and higher in viscosity (Brix), on the other hand, are probably attributed to the utilization of EM in tested area.

After establishing an EM production unit in 1996 at Yedashe sugar mill, utilization of EM solution was markedly promoted through the proper assistance of personnel from extension division. During 1997-98, (74047) litres of EM solution with (802) tons Molasses have been used on 50 thousand hectare for wet season rice production. However, owing to inconsistent rice yield responses, EM inoculated compost known as "Bokashi" was encouraged to use as supplementary organic fertilizer sources for rice in 1998. Furthermore, tremendous efforts have been made to carry out (126) on-farm trials in 10 state and divisions during 1999-2000 in order to verify the effect of EM on rice grain yields.

Table-8. Rice grain yield of EM trials, conducted in Ayeyawady Division during 1999, wet season. (7 treatment × 13 townships)

Sr.No.	Treatment	Grain yield (kg/ha)
1	Control	3291.48 ^{d}
2	EM solution 148 l/ha	3887.82 ^{c}
3	Bokashi 12 t/ha	4105.62 ^{c}
4	FYM 12 t/ha	4165.52 ^{bc}
5	Bokashi 12 t/ha + EM solution 148 l/ha	4528.79 ^{ab}
6	FYM 12 t/ha + EM solution 148 l/ha	4576.09 ^{a}
7	Quick Super Bokashi 25 kg/ha (6 times split)	4206.33 ^{abc}
	F test	**
	C.V. %	**8.75**

As far as the results from Ayeyawady division (table-8) are concerned, highest grain yield can be obtained from EM added FYM treatment. It is obvious that EM increases more rice yield by 10% as compared to FYM alone. Since rice yield differences among EM inoculated compost (Bokashi), FYM and Quick Super Bokashi are not significant, it is an opportunity to replace EM inoculated compost (Bokashi) with Quick Super Bikashi where the collection of raw material for compost making is problem.

Table-9. Rice grain yield of EM trials, conducted in Bago Division during 1999, wet season. (7 treatment × 13 townships)

Sr.No.	Treatment	Grain yield (kg/ha)
1	Control	3061.25 [d]
2	EM solution 148 l/ha	3474.92 [cd]
3	Bokashi 12 t/ha	3905.33 [abc]
4	FYM 12 t/ha	3700.59 [bc]
5	Bokashi 12 t/ha + EM solution 148 l/ha	4245.33 [a]
6	FYM 12 t/ha + EM solution 148 l/ha	4053.61 [ab]
7	Quick Super Bokashi 25 kg/ha (6 times split)	3687.12 [bc]
	F test	**
	C.V. %	**11.13**

In connection with the findings of EM trials conducted in Bago division, 39% rice yield increase over control was observed in Bokashi with additional application of EM solution. Effect of EM on rice was relatively indicated as Bokashi with EM solution gave more rice yield by 9% against Bokashi alone (table-9).

Table-10. Rice grain yield of EM trials, conducted in Yangon Division during 1999, wet season. (7 treatment × 10 townships)

Sr.No.	Treatment	Grain yield (kg/ha)
1	Control	2840.53 [d]
2	EM solution 148 l/ha	3053.44 [cd]
3	Bokashi 12 t/ha	3476.20 [bc]
4	FYM 12 t/ha	3478.56 [bc]
5	Bokashi 12 t/ha + EM solution 148 l/ha	3848.85 [ab]
6	FYM 12 t/ha + EM solution 148 l/ha	3993.00 [a]
7	Quick Super Bokashi 25 kg/ha (6 times split)	3327.06 [c]
	F test	**
	C.V. %	**10.36**

Rice grain yields as affected by Bokashi and FYM with or without additional EM solution, carried out in Yangon division during 1999 wet season were shown in table 10. Although there is no significantly difference in rice yield between Bokashi with EM and FYM with EM, the latter one gave more rice yield than FYM alone as much as 15% indicating positive effect of EM.

Table-11. Rice grain yield of EM trials, conducted in Mandalay Division during 1999, wet season. (7 treatment × 19 townships)

Sr.No.	Treatment	Grain yield (kg/ha)
1	Control	2838.46 [d]
2	EM solution 148 l/ha	3219.94 [c]
3	Bokashi 12 t/ha	3593.55 [b]
4	FYM 12 t/ha	3642.65 [b]
5	Bokashi 12 t/ha + EM solution 148 l/ha	4048.28 [a]
6	FYM 12 t/ha + EM solution 148 l/ha	4141.36 [a]
7	Quick Super Bokashi 25 kg/ha (6 times split)	3787.61 [ab]
	F test	**
	C.V. %	**11.16**

According to the findings of EM trials conducted in Mandalay division during 1999 wet season, either Bokashi or FYM alone can not produce higher rice yield unless additional EM solution is applied. Effect of EM is quite clear here since added EM solution increases 13% yields over either Bokashi or FYM alone.

Table-12. Rice grain yield of EM trials, conducted in Sagaing Division during 1999, wet season. (7 treatment × 9 townships)

Sr.No.	Treatment	Grain yield (kg/ha)
1	Control	3326.96 [c]
2	EM solution 148 l/ha	3876.94 [b]
3	Bokashi 12 t/ha	3939.58 [b]
4	FYM 12 t/ha	4078.58 [ab]
5	Bokashi 12 t/ha + EM solution 148 l/ha	4182.89 [ab]
6	FYM 12 t/ha + EM solution 148 l/ha	4480.27 [a]
7	Quick Super Bokashi 25 kg/ha (6 times split)	3699.53 [bc]
	F test	**
	C.V. %	**9.37**

Highest rice grain yield and 35% increase over control at FYM 12t/ha with EM 148 l/ha were noted comparing other treatments, which were conducted in Sagaing division. It is apparent that effect of EM is much pronounced when it is applied together with either Bokashi or FYM rather than using EM solution alone.

Table-13. Rice grain yield of EM trials, conducted in Magway Division during 1999, wet season. (7 treatment × 24 townships)

Sr.No.	Treatment	Grain yield (kg/ha)
1	Control	2947.15 [d]
2	EM solution 148 l/ha	3537.76 [c]
3	Bokashi 12 t/ha	3659.56 [bc]
4	FYM 12 t/ha	3605.19 [bc]
5	Bokashi 12 t/ha + EM solution 148 l/ha	4097.60 [a]
6	FYM 12 t/ha + EM solution 148 l/ha	4110.11 [a]
7	Quick Super Bokashi 25 kg/ha (6 times split)	3846.75 [ab]
	F test	**
	C.V. %	**9.41**

Results from the Magway division (table-13), on the other hand, is very resemble to that of Mandalay division. Higher rice yields can be anticipated by applying Bokashi or FYM with additional EM solution or Quick Super Bokashi in which rice yield responses are very similar as well. Thus, Qkuick Super Bokashi seems as effective as Bokashi with added EM solution.

Table-14. Rice grain yield of EM trials, conducted in Mon State during 1999, wet season. (7 treatment × 9 townships)

Sr.No.	Treatment	Grain yield (kg/ha)
1	Control	3106.14 [d]
2	EM solution 148 l/ha	3652.67 [c]
3	Bokashi 12 t/ha	3987.25 [abc]
4	FYM 12 t/ha	3814.84 [bc]
5	Bokashi 12 t/ha + EM solution 148 l/ha	4259.85 [a]
6	FYM 12 t/ha + EM solution 148 l/ha	4153.71 [ab]
7	Quick Super Bokashi 25 kg/ha (6 times split)	4234.79 [a]
	F test	**
	C.V. %	**7.28**

Rice grain yields from EM trials conducted in Mon State are shown in table 14. Rice yields were observed to be increased as much as 16% over yielded control by the application of Bokashi with added EM solution, or Quick Super Bokashi. Since it is low demand for raw materials needed to make Quick Super Bokashi, it is probable to adopt as alternate organic fertilizer source for rice production where the availability of crop residues and other raw materials are encountered as major constraint.

Table-15. Rice grain yield of EM trials, conducted in Shan State during 1999, wet season. (7 treatment × 10 townships)

Sr.No.	Treatment	Grain yield (kg/ha)
1	Control	2899.95 [c]
2	EM solution 148 l/ha	3701.57 [b]
3	Bokashi 12 t/ha	4055.99 [ab]
4	FYM 12 t/ha	4270.38 [ab]
5	Bokashi 12 t/ha + EM solution 148 l/ha	4756.90 [a]
6	FYM 12 t/ha + EM solution 148 l/ha	4595.40 [a]
7	Quick Super Bokashi 25 kg/ha (6 times split)	6419.04 [a]
	F test	**
	C.V. %	**14.52**

As findings of EM trials conducted in Shan State, rice yields are well responded to either Bokashi or FYM with or without added EM solution except EM solution alone. Effect of Quick Super Bokashi on rice yield however, is more or less the same as Bokashi or FYM with EM solution and it gave rice yield highest and 64% out-yielded control.

Table-16. Rice grain yield of EM trials, conducted in Kayin State during 1999, wet season. (7 treatment × 4 townships)

Sr.No.	Treatment	Grain yield (kg/ha)
1	Control	2547.32 [c]
2	EM solution 148 l/ha	3140.34 [abc]
3	Bokashi 12 t/ha	3218.36 [abc]
4	FYM 12 t/ha	3374.41 [ab]
5	Bokashi 12 t/ha + EM solution 148 l/ha	3494.79 [ab]
6	FYM 12 t/ha + EM solution 148 l/ha	3725.25 [a]
7	Quick Super Bokashi 25 kg/ha (6 times split)	2876.02 [bc]
	F test	**
	C.V. %	**10.87**

According to the results reported from Kayin State, 46% rice yield increase over control was achieved because of applying FYM with additional EM solution. As yield responses among the treatments with or without EM are not statistically significant, the effect of EM on rice yield in tested area are not clear so far.

Table-17. Rice grain yield of EM trials, conducted in Rakhine State during 1999, wet season. (7 treatment 15 townships)

Sr.No.	Treatment	Grain yield (kg/ha)
1	Control	3193.28 [c]
2	EM solution 148 l/ha	3638.30 [bc]
3	Bokashi 12 t/ha	3930.89 [ab]
4	FYM 12 t/ha	3823.08 [ab]
5	Bokashi 12 t/ha + EM solution 148 l/ha	4354.95 [a]
6	FYM 12 t/ha + EM solution 148 l/ha	4373.28 [a]
7	Quick Super Bokashi 25 kg/ha (6 times split)	4100.23 [ab]
	F test	**
	C.V. %	**15.26**

Regarding rice grain yields recorded in EM trials, conducted in Rakhine State during 1999, wet season, all treatments consisted except EM solution alone increase rice grain yield as compared to control. Rice yield increases were much pronounced in Bokashi or FYM with additional application of EM solution 148 l/ha.

As the salient finding on all trials implemented in 10 states and divisions during 1999, higher rice grain yield can be achieved by using either Bokashi or FYM 12 t/ha with additional application of EM solution 148 l/ha rather than individual applying Bokashi, FYM, or EM solution alone. Combined application of Bokashi or FYM with EM solution can generally be out-yielded as much as 40% against control (no fertilizer plots).

_. Current situation of EM production and utilization.

At the beginning of the EM utilization program in Myanmar soon after having technical collaboration with APNAN, and INFRC, EM concentrates were provided to make testing the effectiveness of EM on different crops.

Mass production of EM solution was initiated after establishing EM production unit at Yedashe Sugar Mill in 1996. Yearly capacity of production is shown in table-18. Domestic production of EM solution from 1997 through 2000 would be as much as 0.31 million litres which would be added into 0.02 million tons of Molasses to make EM working solution for either direct application or for making compost (Bokashi).

Table-18. Production of EM solution (L).

Year	EM solution (litre)	Molasses (ton)	Area(ha),expected
1997-98	74047	802	48583
1998-99	32075	1339	32389
1999-2000	36000	5600	121457
2000-2001	170000	13033	1619433
total	**312122**	**20774**	

Table-19. Area under annual utilization of EM on different crops.

Year	Hectare					
	Rice	Maize	Vegetables	Sugarcane	Cotton	Total
1993-94	364	-	-	-	-	364
1994-95	12146	-	-	-	-	12146
1995-96	20243	2024	2024	40	40	24371
1996-97	141700	-	-	-	-	141700
1997-98	49595	-	-	-	-	49595
1998-99	33357	-	322	-	-	33679
1999-2000	99597	-	-	-	-	99597
2000-2001	404858	-	-	-	-	404858

The use of EM was practically started in 1993-94 for monsoon rice production and its utilization has been markedly increased within a few years in some other crops as well. Within 1993 to 1996 the area of rice growing under EM application was maximized at (141700) ha due to the easiness in applying EM solution. However, owing to inconsistent rice yield responses, the use of EM has diminished in 1997. Thus, EM inoculated compost (Bokashi) encouraging to use as organic fertilizer has been increasing accordingly up to (404858) ha in 2000-2001.

Furthermore, 0.34 million litres of EM concentrate will be produced in 2001-2002 to mix with 0.026 million tons of molasses in order to make EM working solution which will be well sufficient for 0.4 million hectres, occupying 7.5% of total rice growing area. There is a plan to use EM produced in direct application as EM solution, making compost (Bokashi), and in Quick Super Bokashi as inoculants. In future, some satellite EM production units will be established in particular townships to minimize the EM production cost regarding transportation of EM solution and molasses needed for EM multiplication and in order to extend the effective rice growing area under EM utilization.

_V. Activities of EM technology dissemination

With the objectives of well understanding in formulation and preparation of EM solution, systematic EM inoculated compost making and proper application of EM solution and Bokashi, training on utilization of EM are regularly organized by MAS for the capacity building of extension agents, farm managers and staff from seed and horticulture division and of teaching staffs from Yezin Agriculture University (YAU).

Table-20. EM training from 1994 to 2000.

Year	No. of training	No. of participants
1994	3	156
1995	4	253
1996	3	152
1997	3	134
1998	2	250
1999	1	65
2000	1	56
Total	**17**	**1066**

Workshops on EM technology were also held in 1994 and 1999 at CARDC, Hlegu township with the participation of officials from state and divisions. It is motivated to evaluate their findings and to address constraints and possibilities so that some decision can be made for the development and implementation of future EM utilization program.

Moreover, demonstration cum-trials and field days were occasionally organized by extension agents in respective townships to make as "seeing is believing" so that EM technology penetrates into the farmers.

V. Constraints and outlook for the development of EM technology.

Although the positive effects of EM solution and EM inoculated compost (Bokashi) on rice in terms of grain yield and fertilizer cost were clearly demonstrated in majority of the area tested, some farmers are still reluctant to use EM in crop production.

Some possibilities to be undertaken in accord with the constraints encountered are mentioned below:

Sr.No.	Constraints	Causes	Possibilities
1	Delay adoption of EM technology	-less capacity building -new technology	-more demonstration cum-trial as farmer's participatory approach
2	Inconsistent rice yield responses by EM solution alone	-short term observation -improper application	-use of Bokashi with EM solution for long terms.
3	Reluctant to make Bokashi	-scarcity of raw materials and crop residues in some area	-low raw material requiring Bokashi (Super Bokashi or Quick Super Bokashi) should be introduced.
4	Weak in capacity building and shortage of trained personnel on EM technology	-less opportunity to attend EM training -less availability of EM journal/publications	-in-country as well as over sea trainings are needed -regular imformation regarding EM technology should be provided.
5	Untimely distribution of EM to states and divisions and high cost of transportation of EM concentrate and molasses	-only one EM production unit and it's far from application sites	-establishment of satellite EM production units should be implemented

V_. Conclusion

Since 1993-94 after introducing EM technology in Myanmar, despite rice yield increases were not consistent due to EM application at the very beginning of the EM utilization program, relatively farmers' acceptance and apparent rice yield improvements have been achieving in many rice growing areas. Utilizations of EM technology in terms of using EM solutions as direct spraying, of inoculating EM in Bokashi making and in preparation of Quick Super Bokashi was actively implemented with full swing throughout the country by the selfless organization and coordination of regional authorized personnel, and energetic effort of EM technicians.

Technology transfer of EM will be proceed through the strong participation and close supervision of MAS officials along with the convince of farmers on EM technology.

More effort on utilization and dissemination of EM technology will be exercised with momentum in future for the sake of establishing environment friendly practices, saving fertilizer cost and of sustaining crops productivity.